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Anderson

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(54) **COUNTER WRAP CORD DRIVE**

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(52) **U.S. Cl.** .... **160/170**; 160/173 R; 160/178.1 R
(58) **Field of Search** .... 160/170, 171, 160/168.1 R, 173 R, 176.1 R, 177 R, 178.1 R; 74/89.22; 242/613.1, 407

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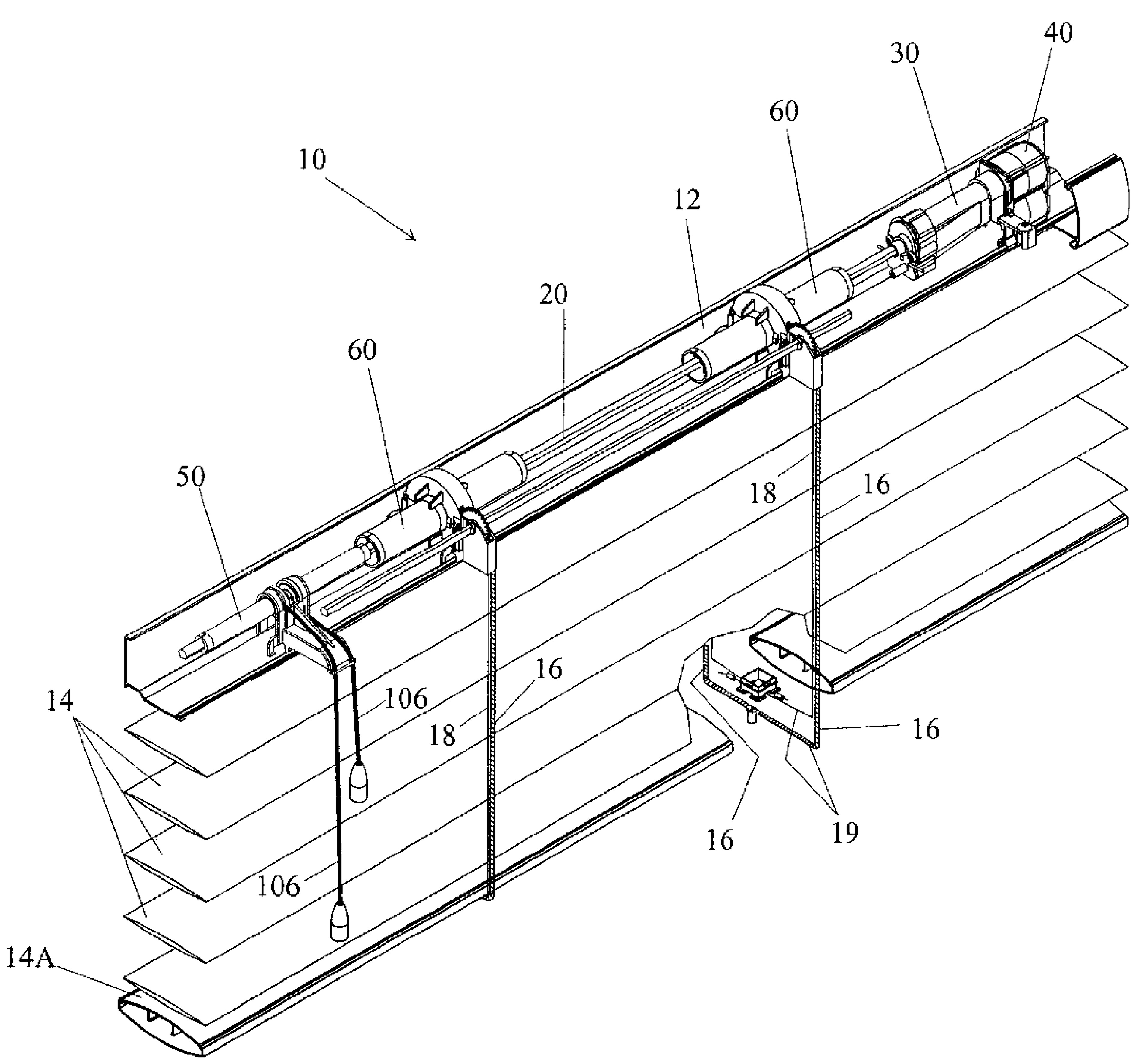
(74) *Attorney, Agent, or Firm*—Camoriano & Associates; Theresa F. Camoriano; Guillermo E. Camoriano

(57) **ABSTRACT**

A cord drive has two cords mounted on two spools. Pulling the first cord unwraps the first cord from the first spool, causes a drive shaft to rotate in one direction, and causes the second cord to wrap onto the second spool. Pulling the second cord unwraps the second cord from the second spool, causes the drive shaft to rotate in the opposite direction, and causes the first cord to wrap onto the first spool.

42 Claims, 11 Drawing Sheets



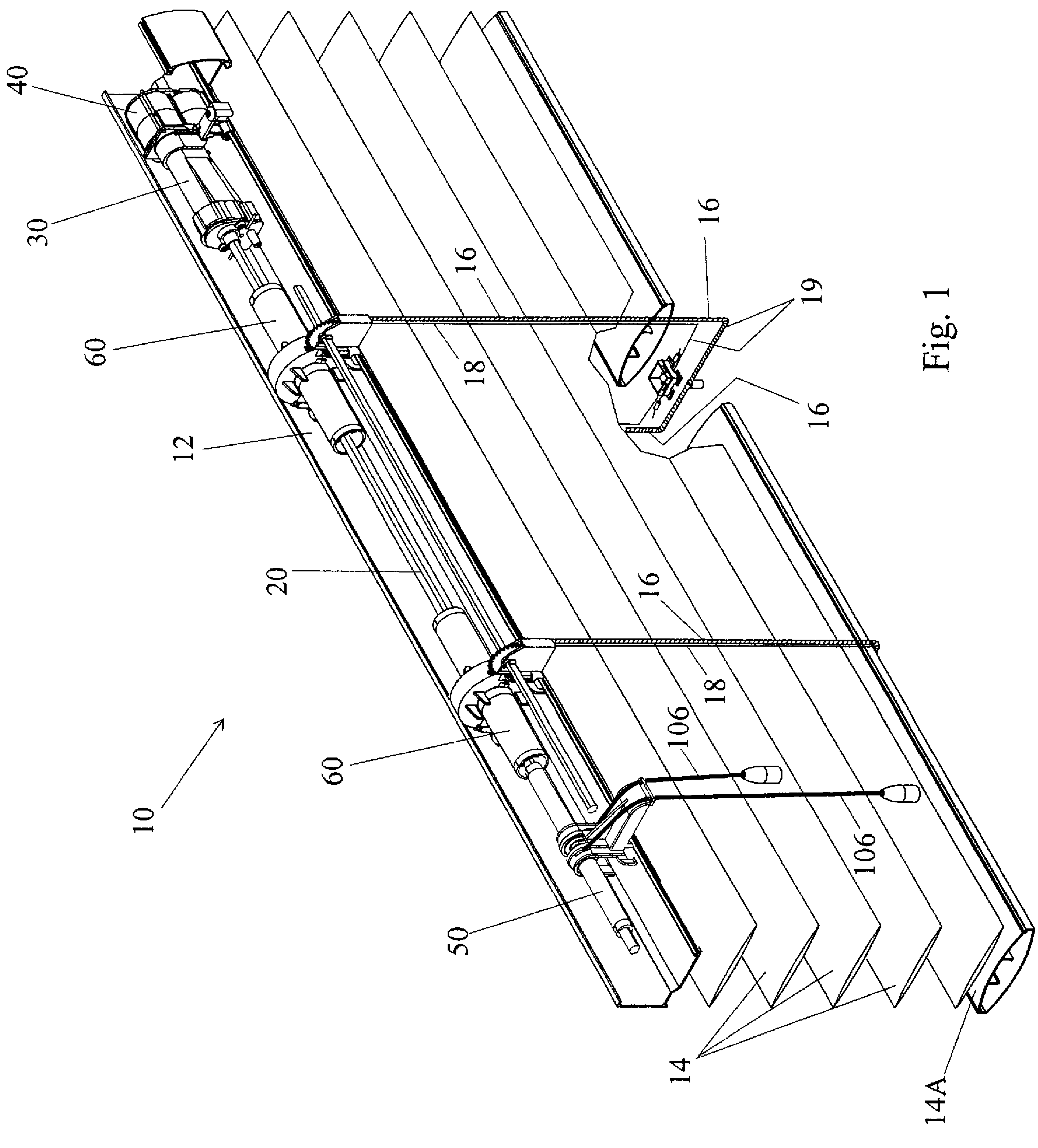


Fig. 1

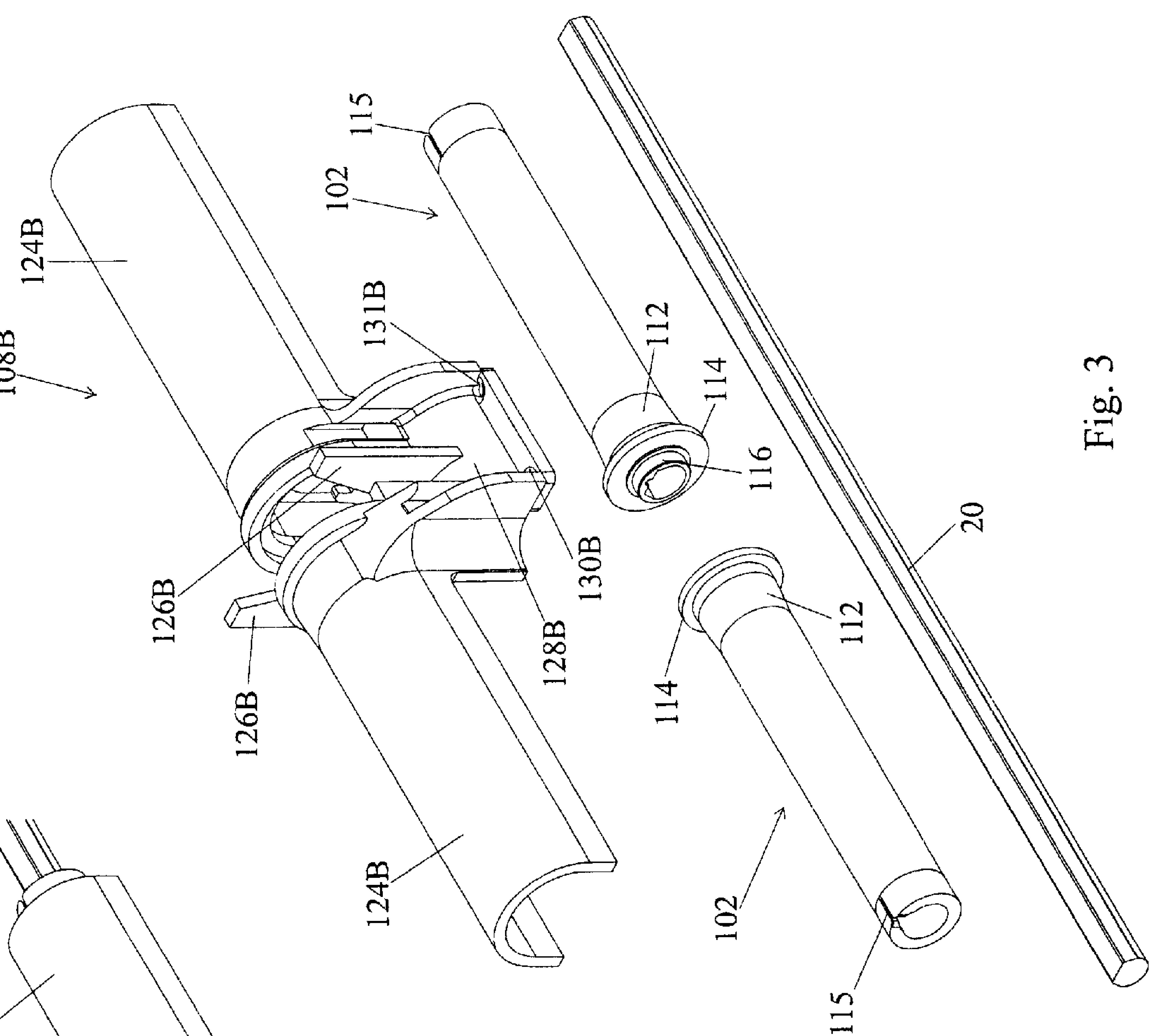

108B
124B
115
102
131B
112
114
116
126B
130B
126B
128B
124B
114
112
20
102
115

Fig. 3

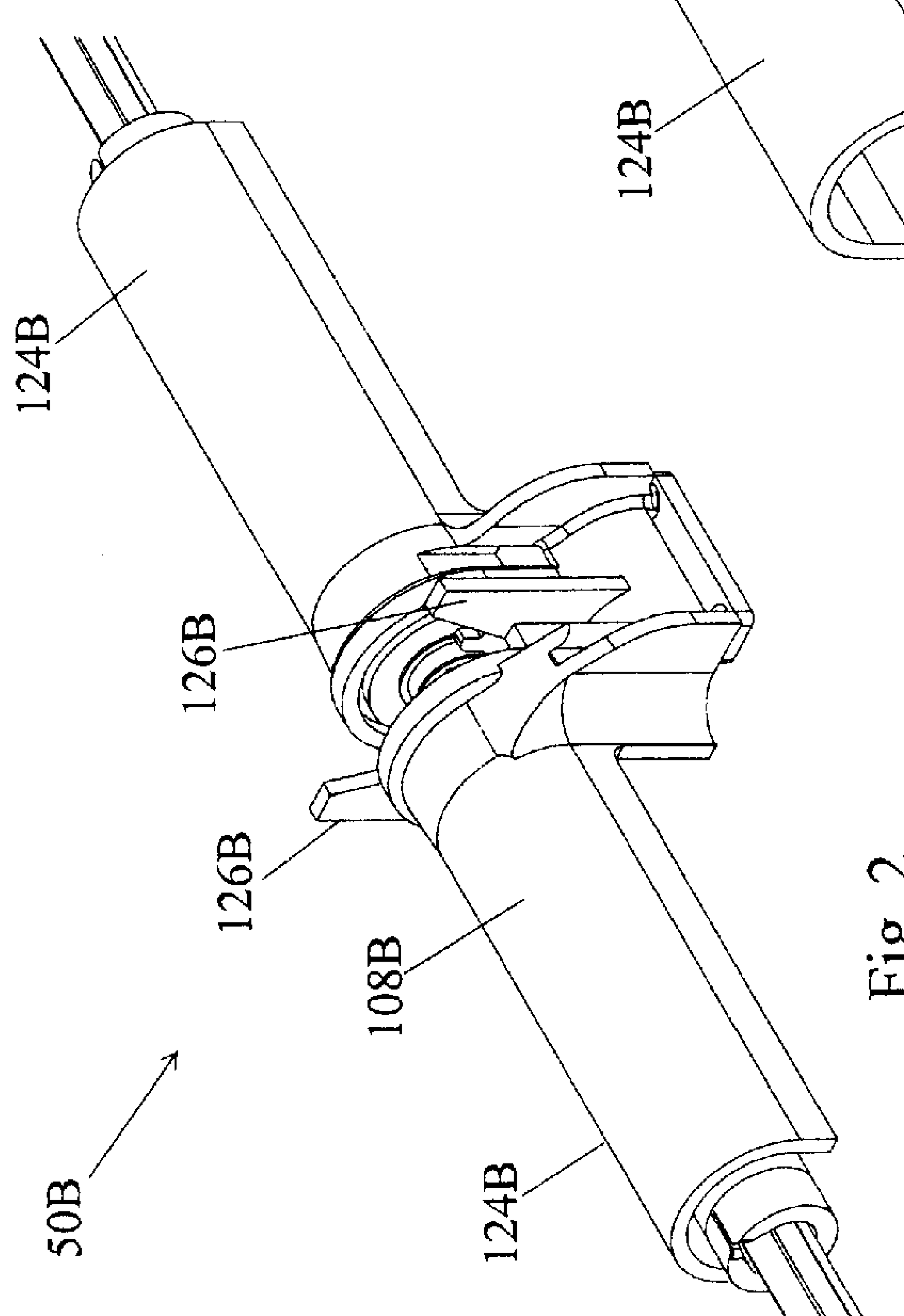

124B
126B
126B
108B
124B
50B

Fig. 2

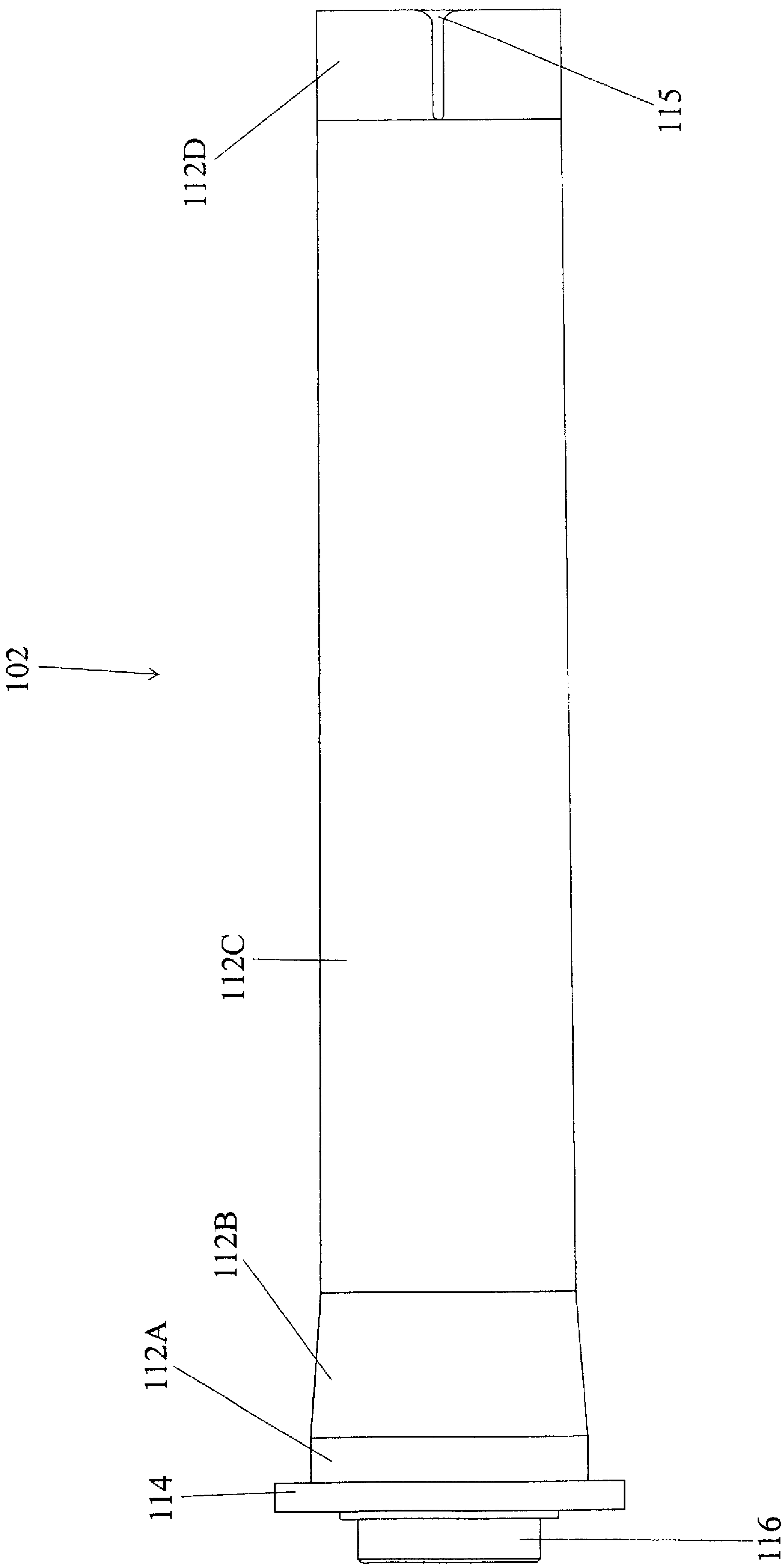


Fig. 3a

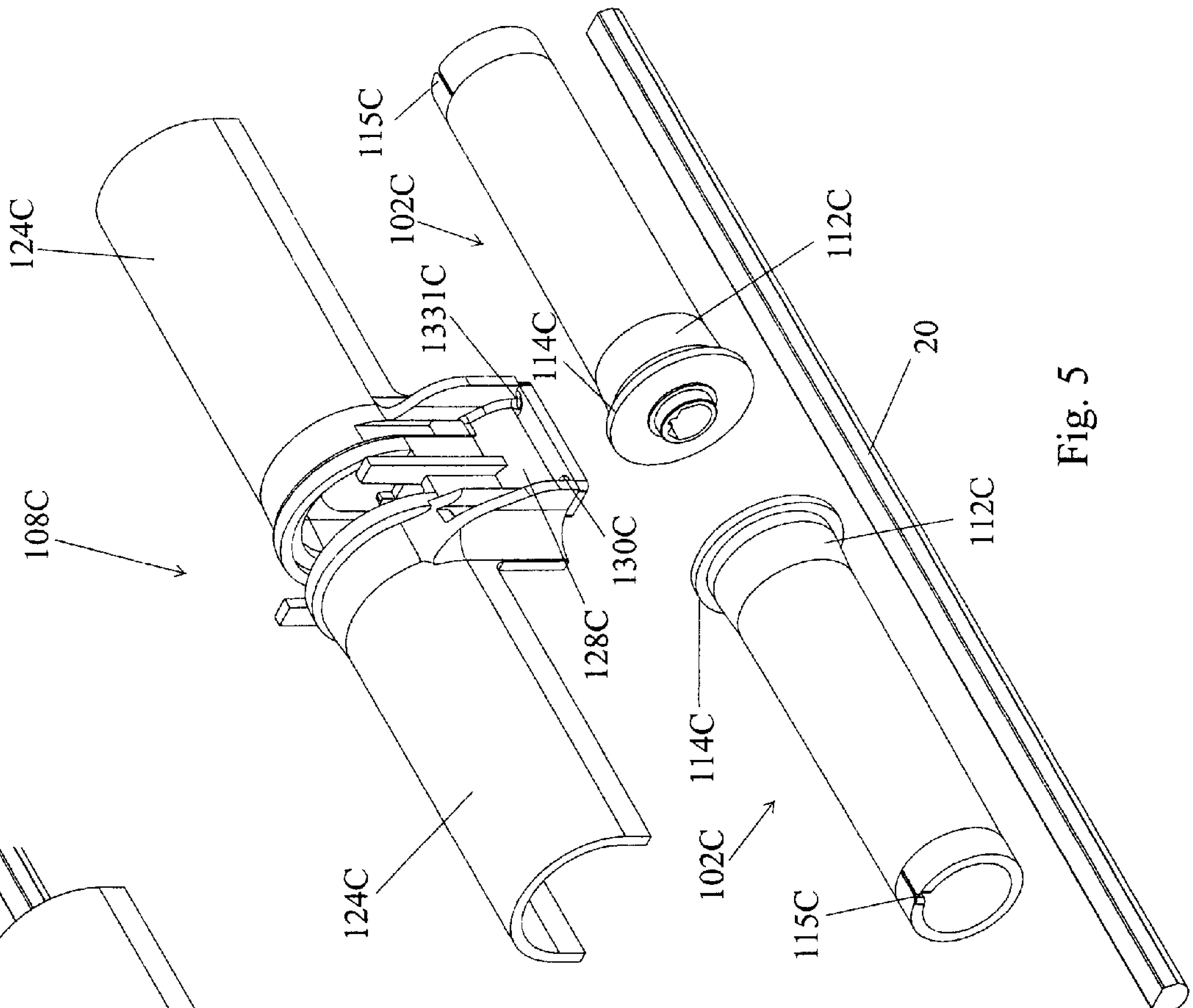
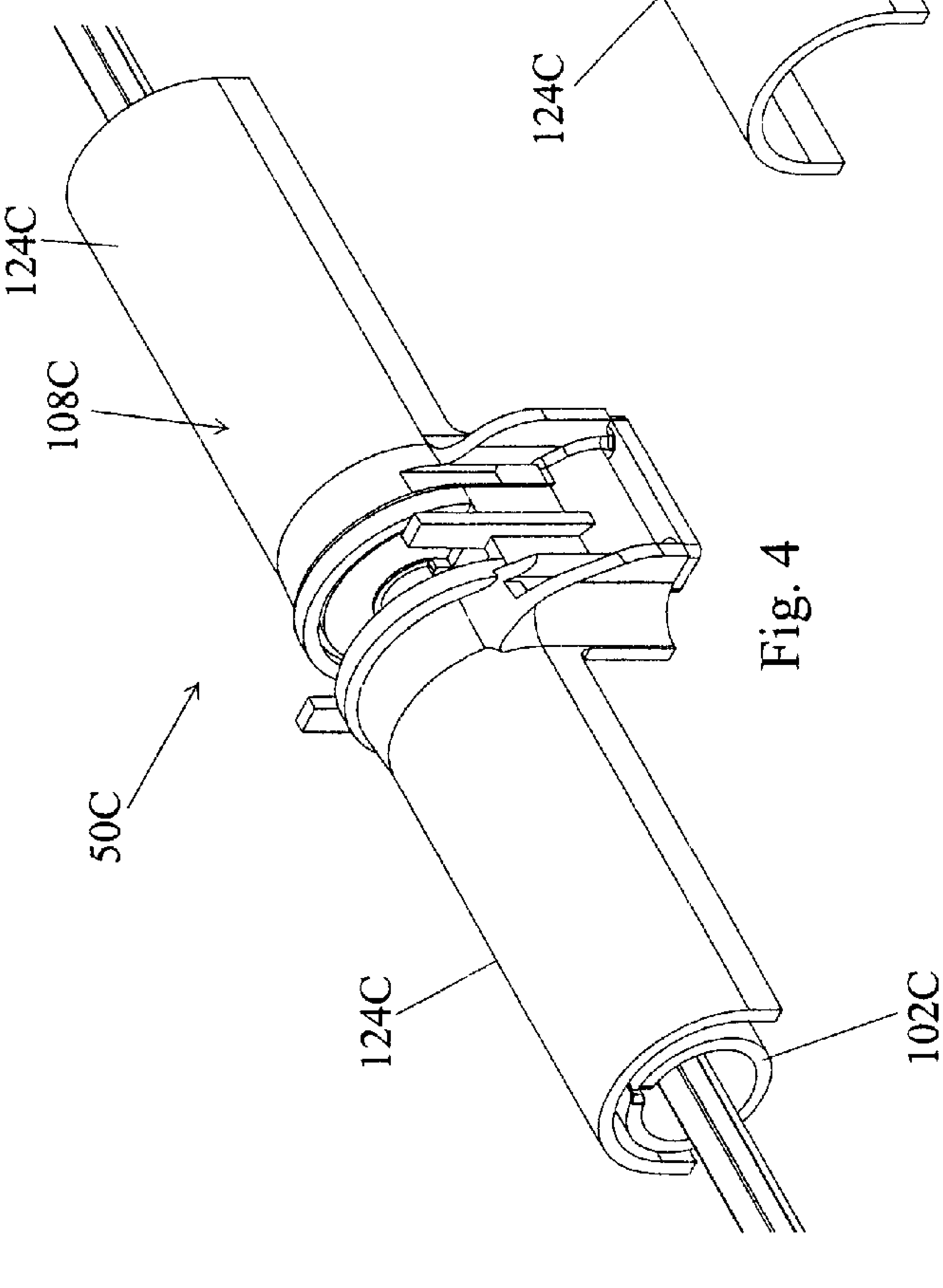

115C
102C
124C
1331C
114C
112C
20
108C
130C
112C
128C
114C
124C
102C
115C

Fig. 5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108C
50C
124C
102C

Fig. 4

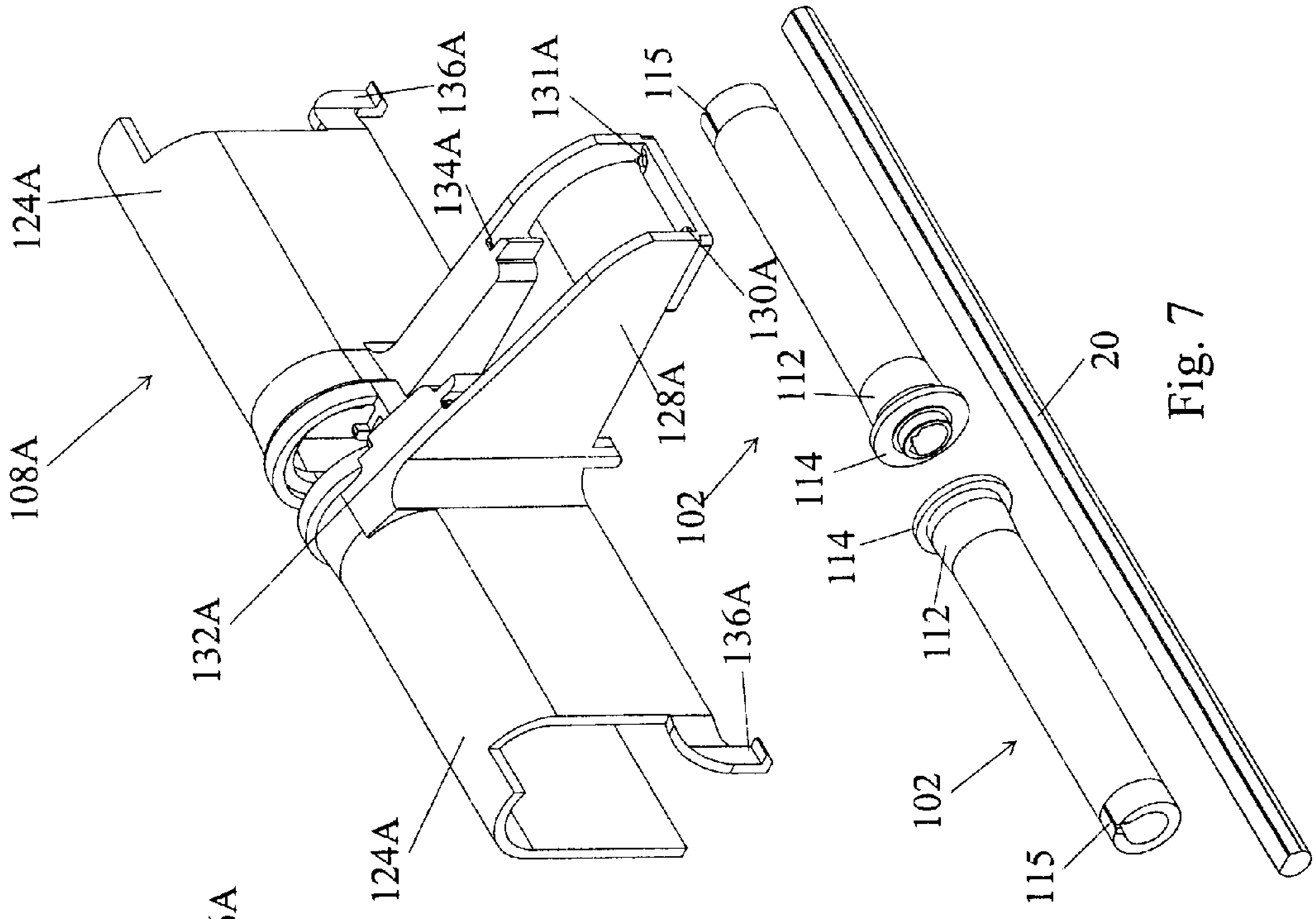
124A
108A
136A
134A
131A
115
130A
128A
112
114
102
132A
20
136A
114
112
124A
102
115

Fig. 7

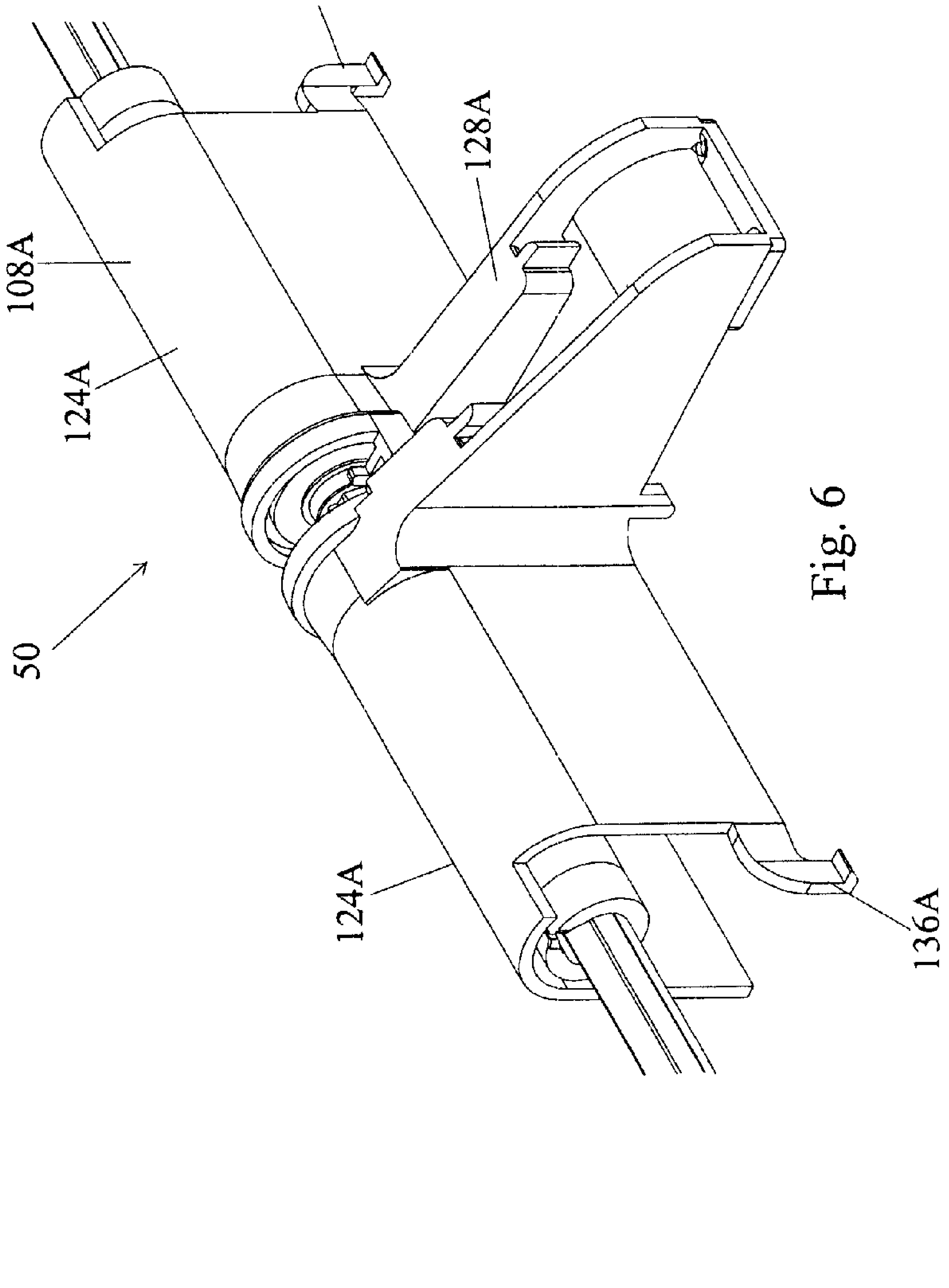
136A
108A
128A
124A
50
124A
136A

Fig. 6

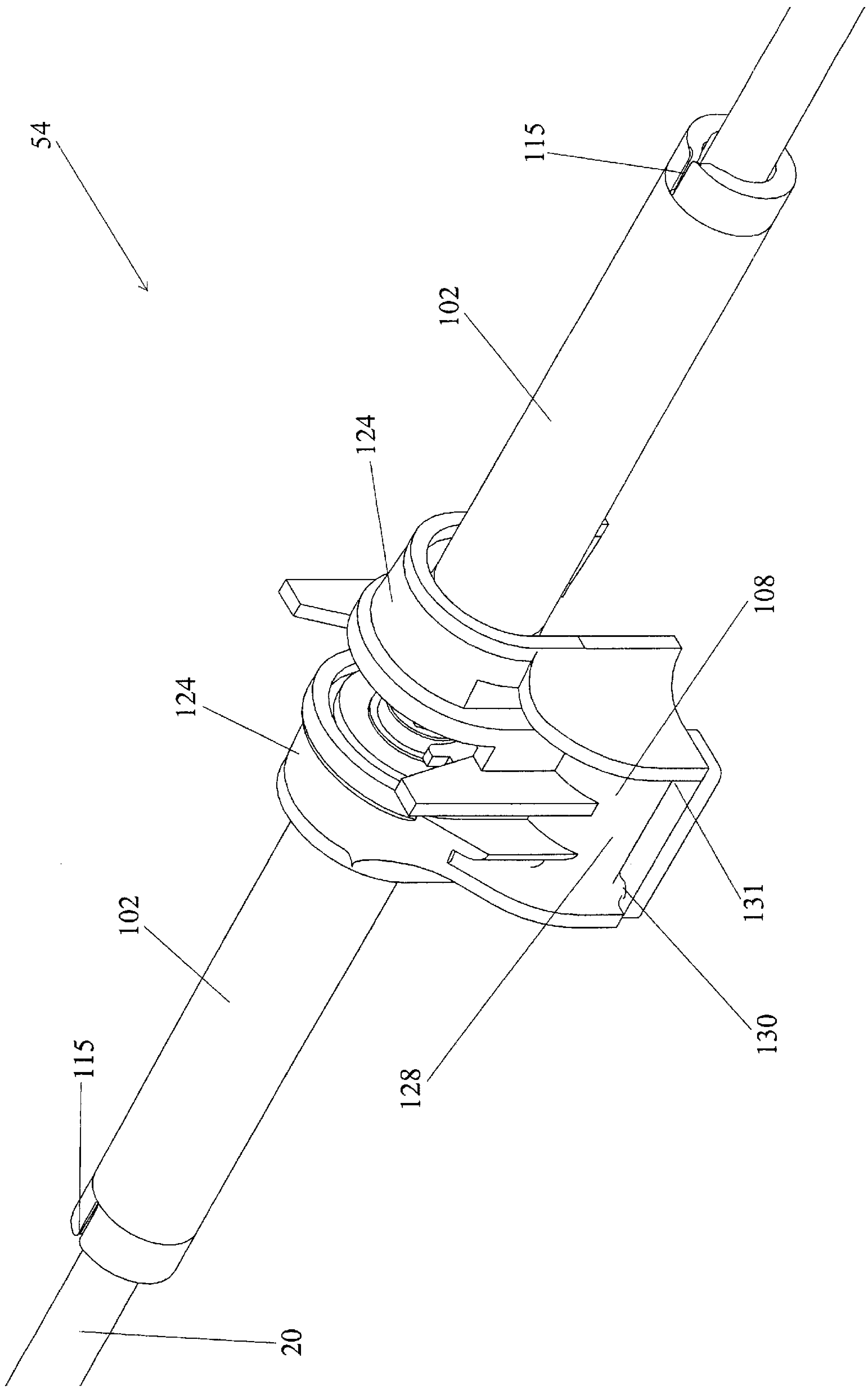

Fig. 8

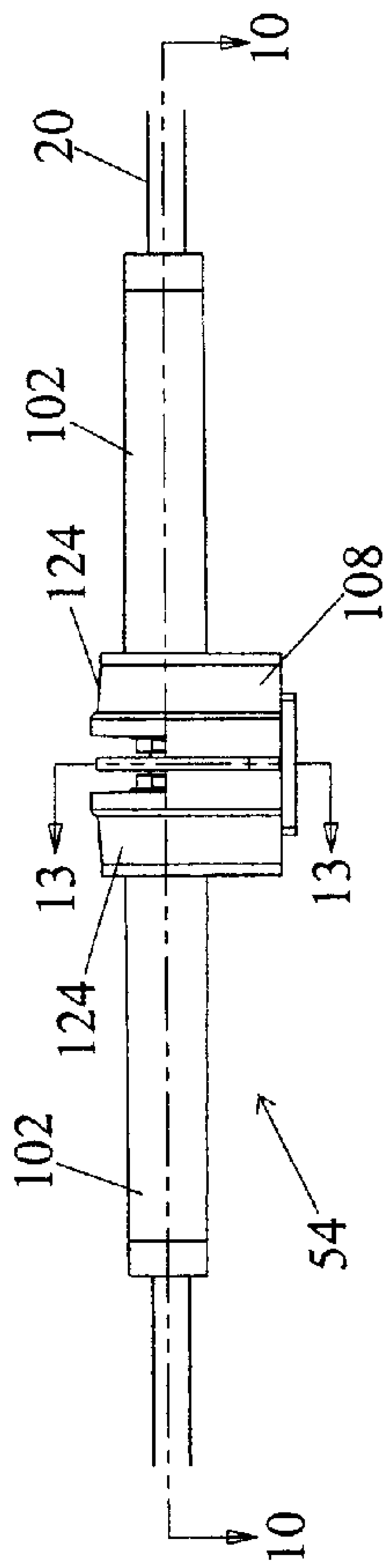

Fig. 9

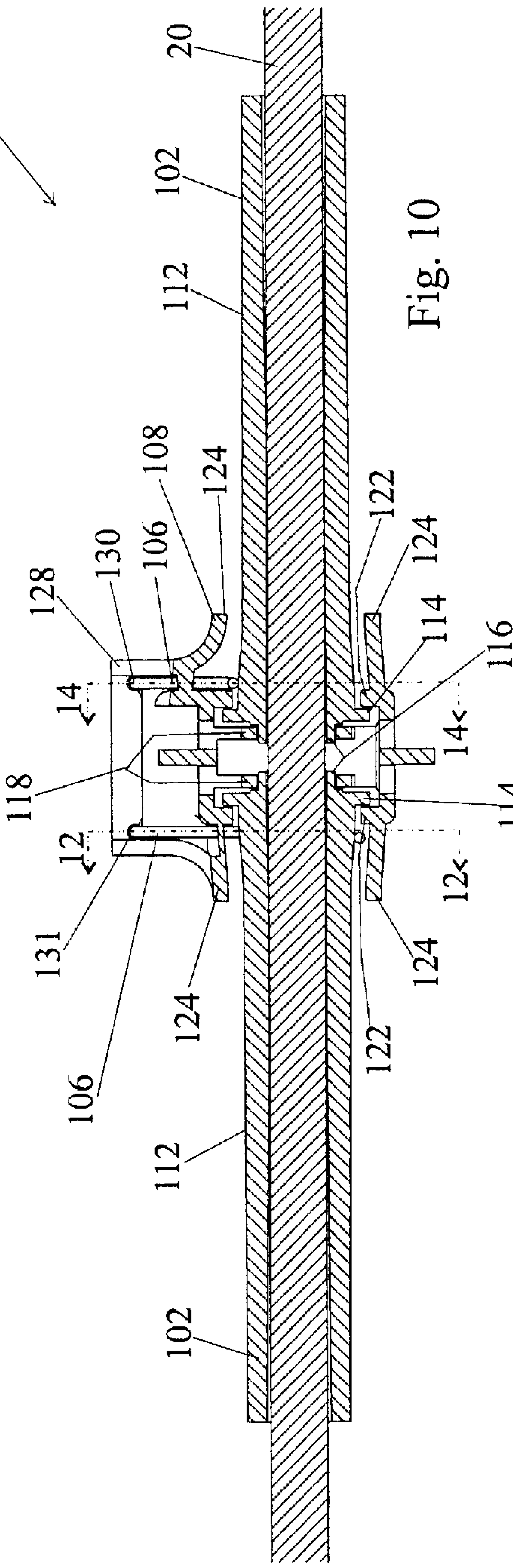

Fig. 10

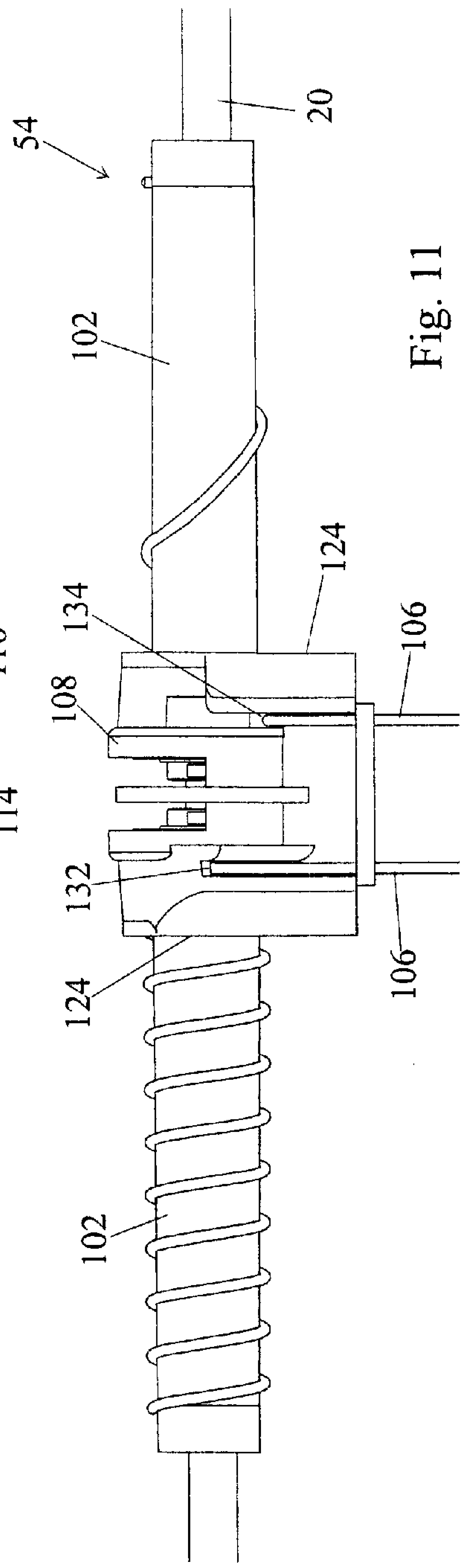

Fig. 11

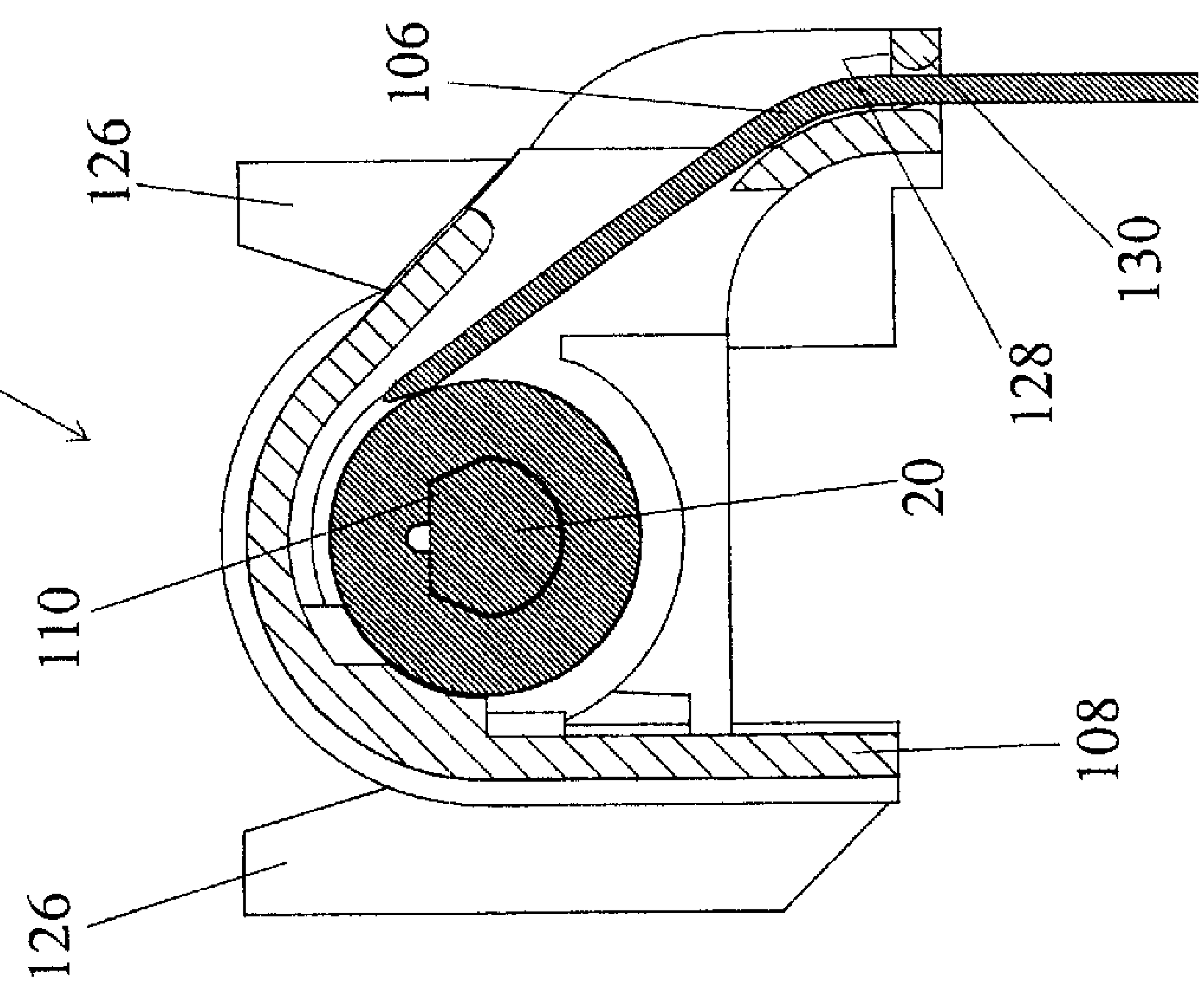

Fig. 14

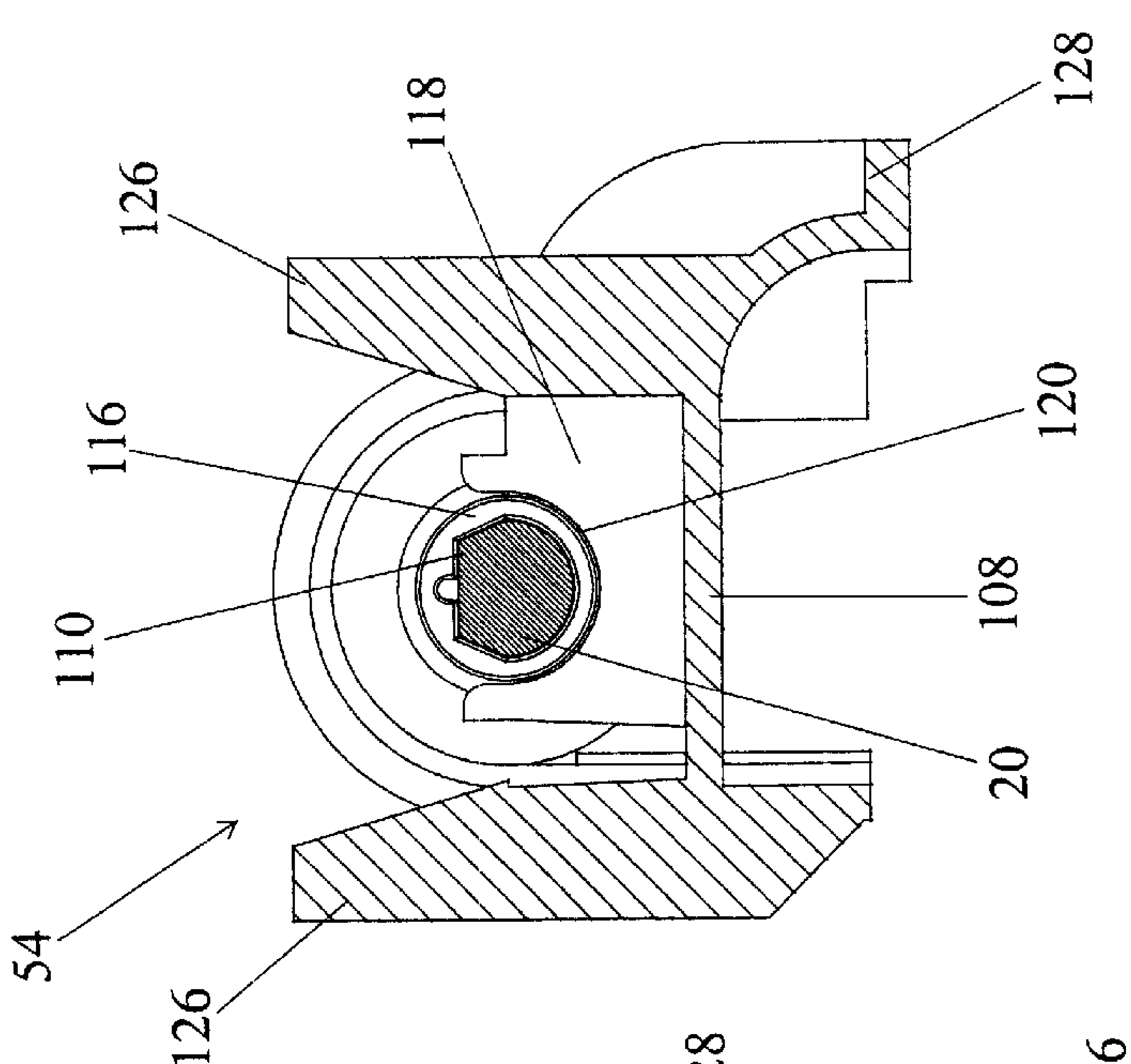

Fig. 13

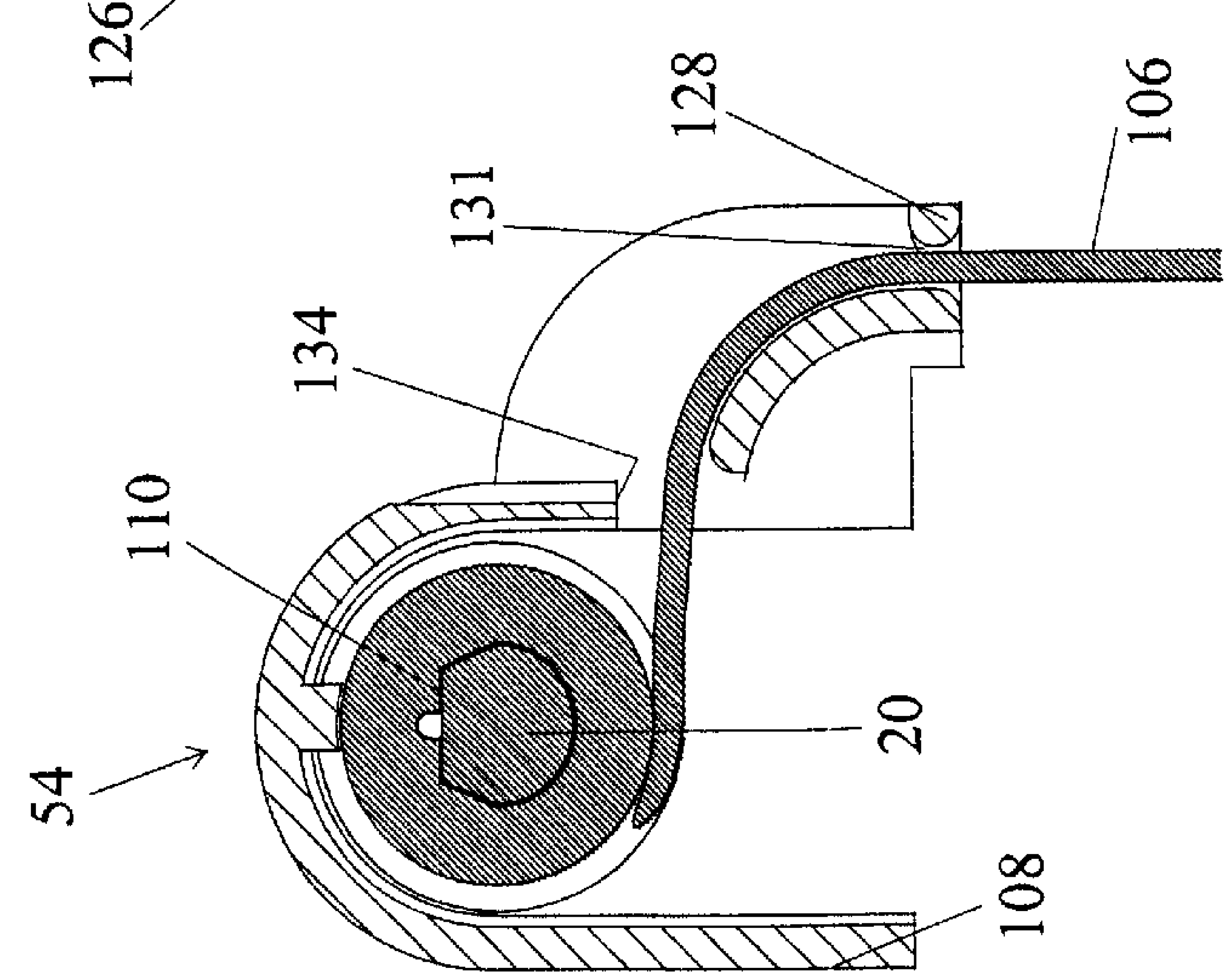

Fig. 12

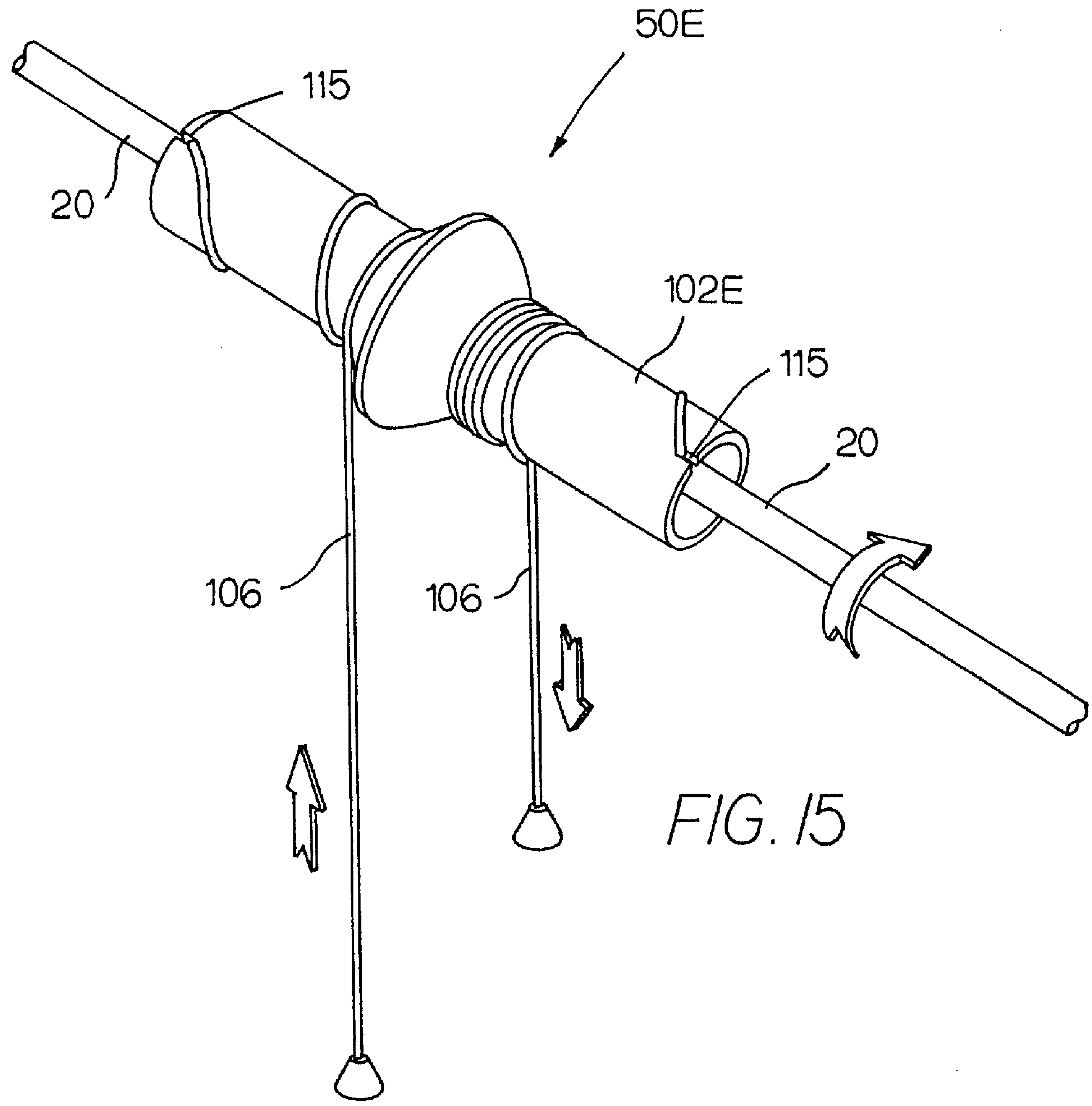

FIG. 15

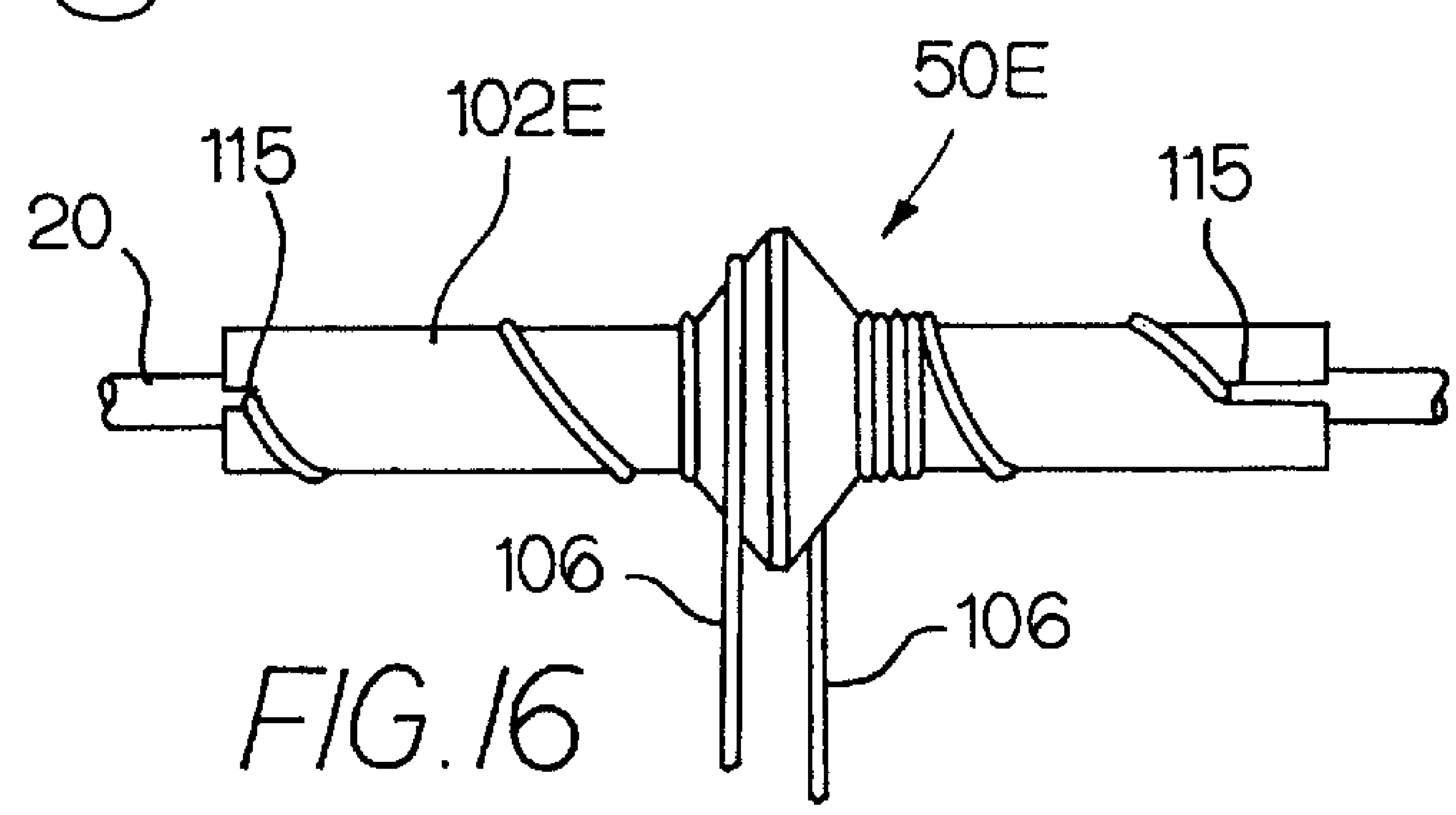

FIG. 16

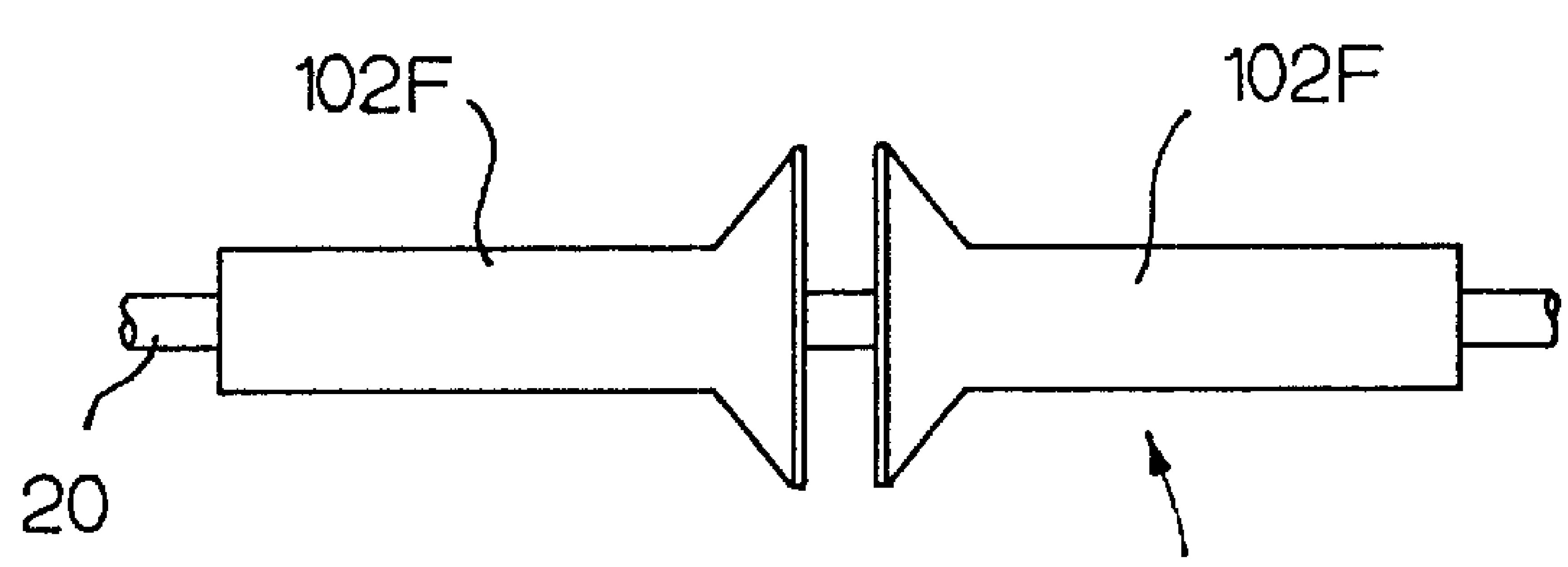

FIG. 17

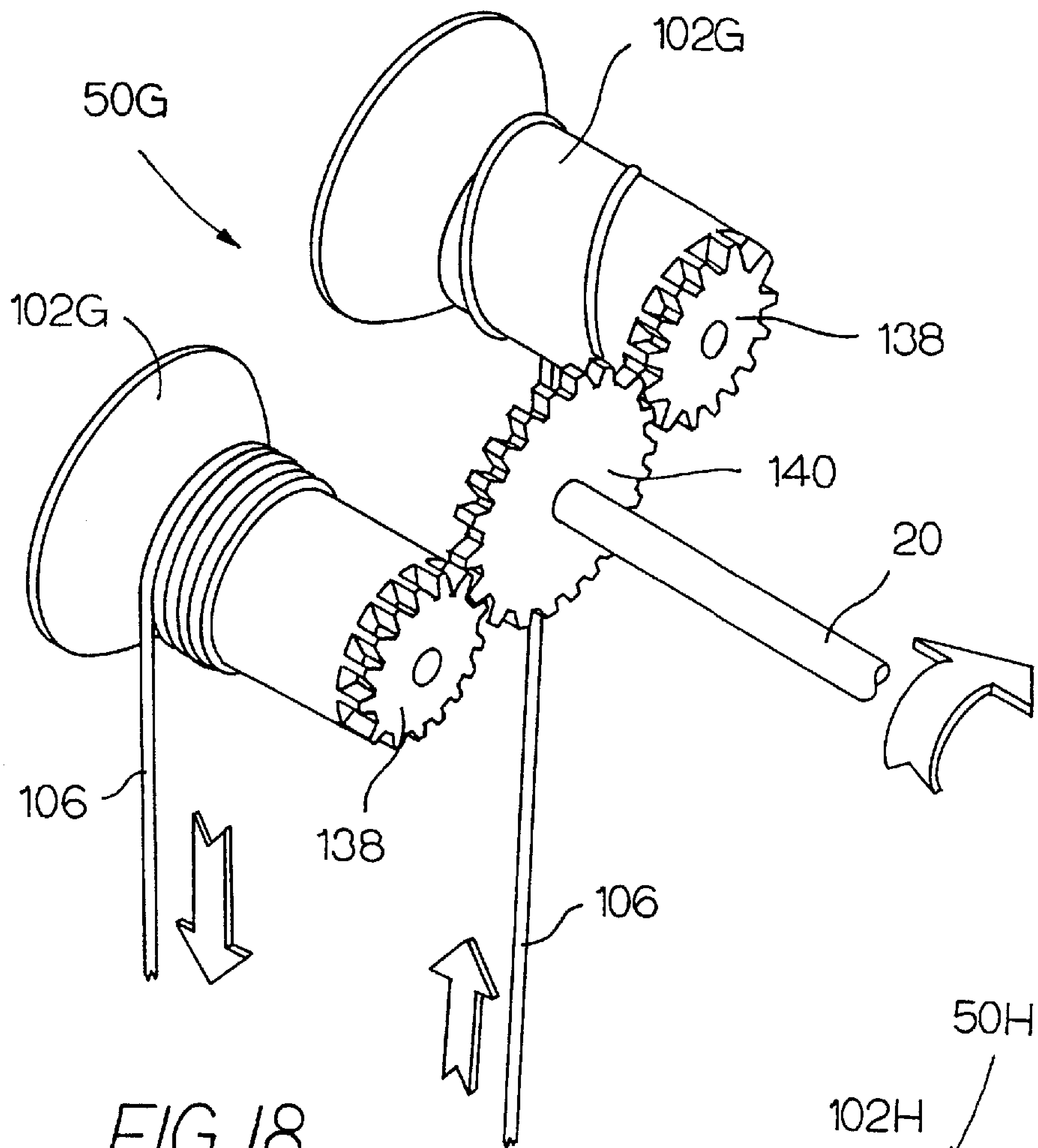
50G
102G
102G
138
140
20
106
138
106

FIG. 18

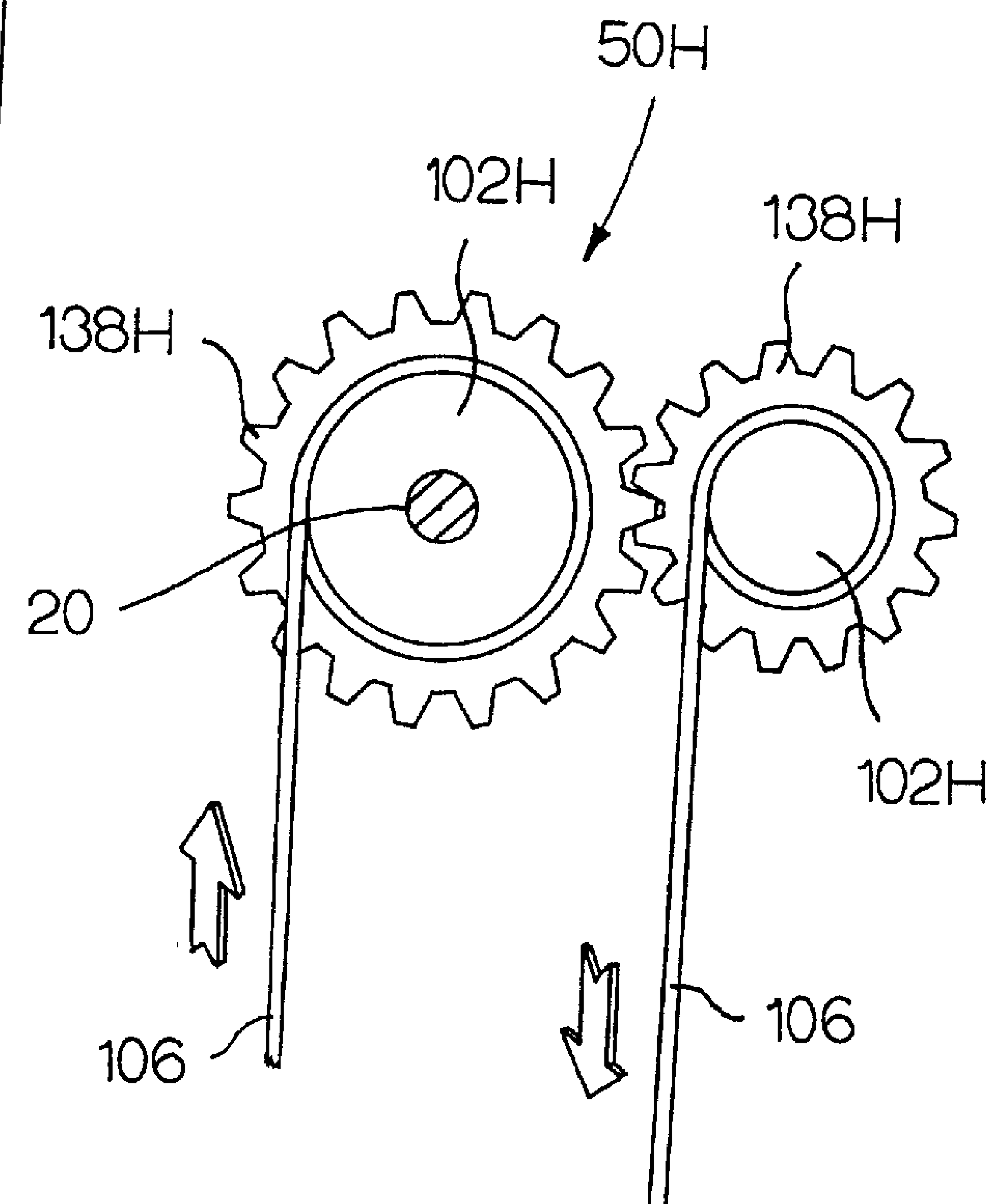
50H
102H
138H
138H
20
102H
106
106

FIG. 19

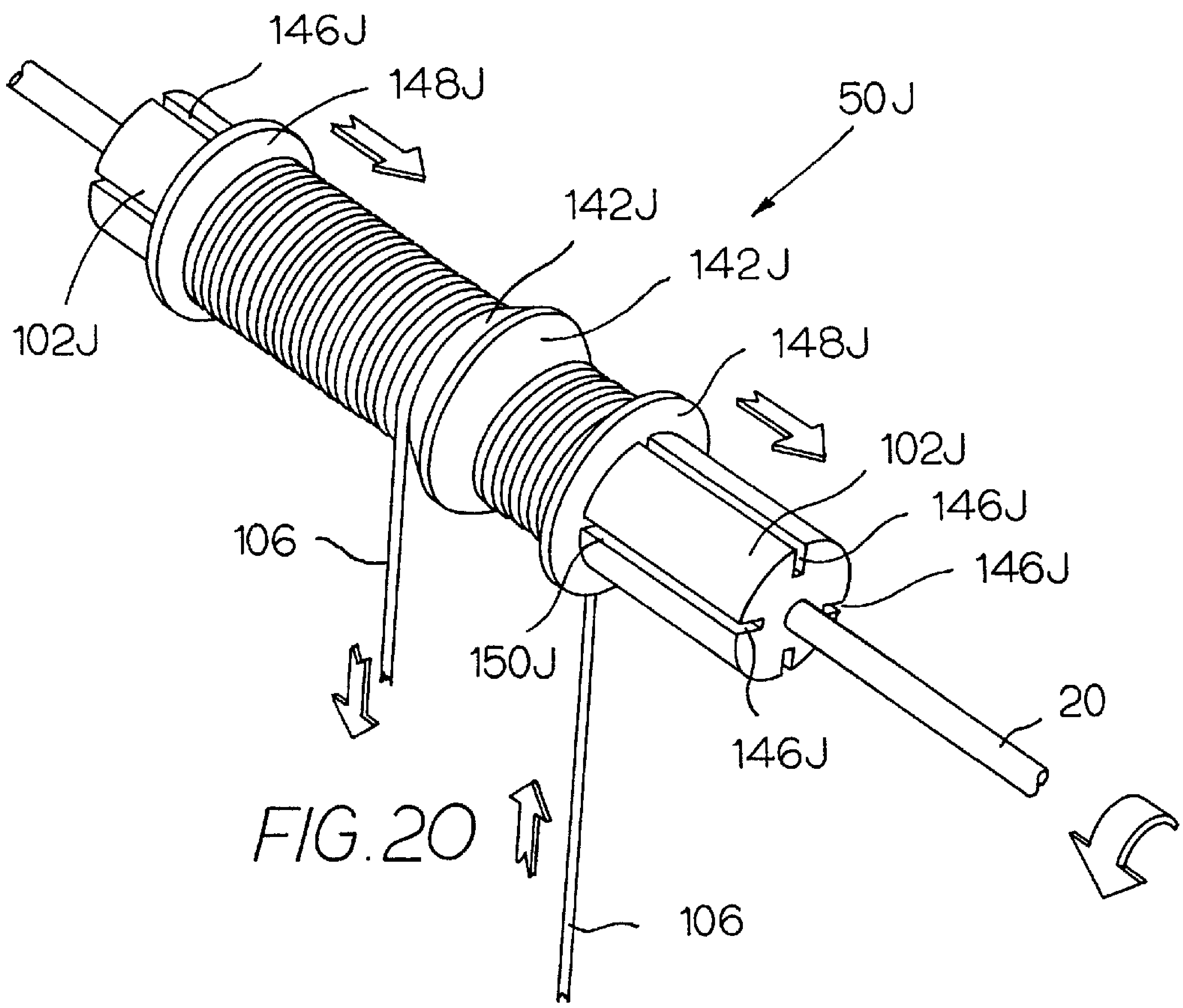
146J
148J
50J
142J
142J
102J
148J
102J
106
146J
146J
150J
20
146J
106

FIG. 20

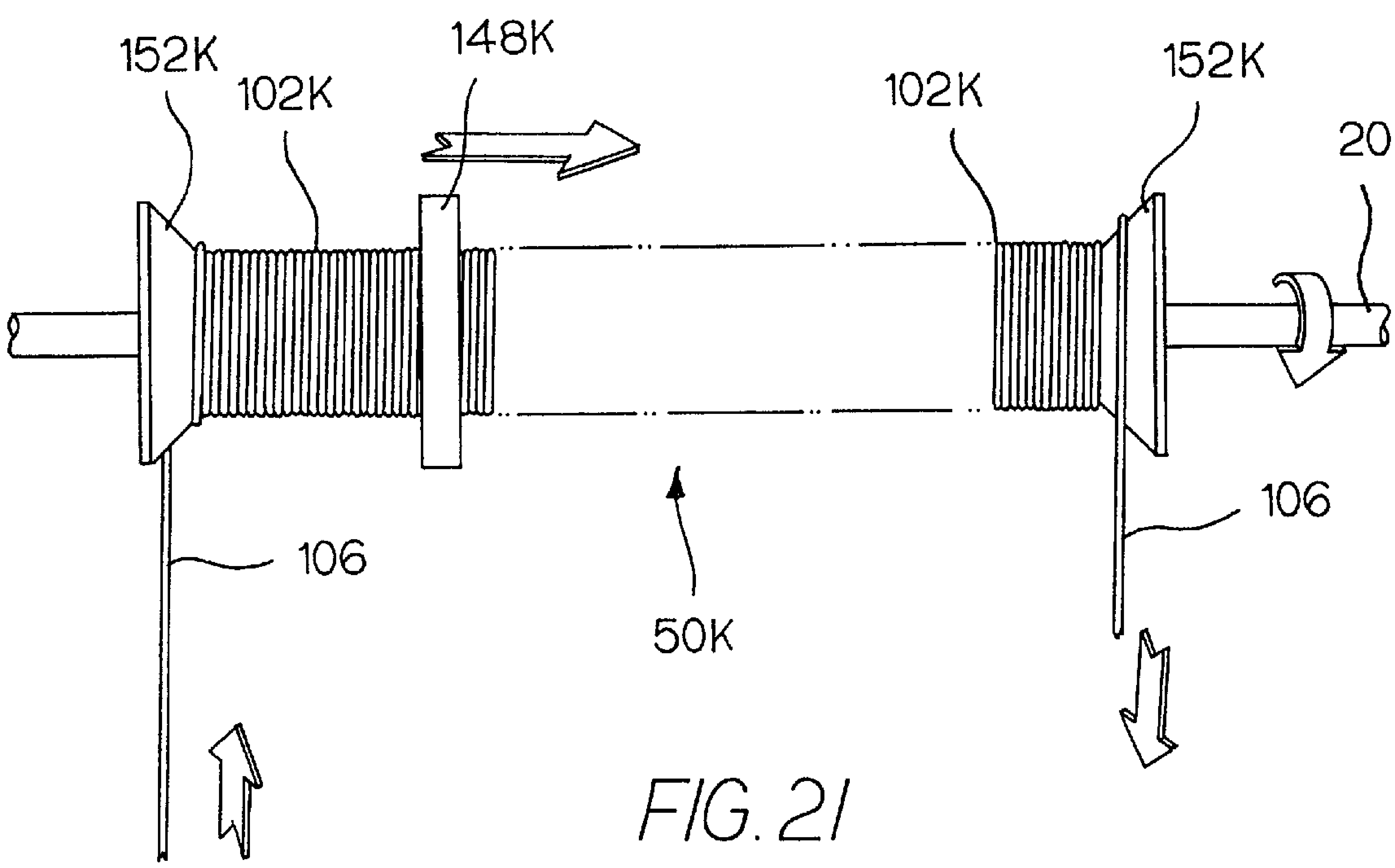
152K
102K
148K
102K
152K
20
106
106
50K

FIG. 21

COUNTER WRAP CORD DRIVE

This application claims priority from U.S. Provisional Application S. No. 60/219,926, filed Jul. 21, 2000.

BACKGROUND OF THE INVENTION

The present invention relates to a cord drive for producing rotary motion. In the embodiments shown here, the cord drive is used for raising and lowering coverings for architectural openings such as Venetian blinds, pleated shades, and other blinds and shades. This cord drive may also be used on vertical blinds and other mechanical devices requiring rotary motion.

Typically, a blind transport system will have a top head rail which both supports the blind and hides the mechanisms used to raise and lower or open and close the blind. Such a blind system is described in U.S. patent application Ser. No. 09/528,951, filed Mar. 20, 2000, which is hereby incorporated by reference. The raising and lowering is done by a lift cord attached to the bottom rail (or bottom slat). The opening and closing of the blind is typically accomplished with ladder tapes (and/or tilt cables) which run along the front and back of the stack of slats. The lift cords (in contrast to the tilt cables) may either run along the front and back of the stack of slats or they may run through slits in the middle of the slats, and are connected to the bottom rail.

A wide variety of drive mechanisms is known for raising and lowering blinds and for tilting the slats. A cord drive to raise or lower the blind is very handy. It does not require a source of electrical power, and the cord may be placed where it is readily accessible, getting around any obstacles.

In prior art cord drives used for blinds, it is typical for the same cord to be used to drive the lift action and to extend through the slats and fasten to the bottom slat (or bottom rail) to lift the blind.

Known cord drives have some drawbacks. The cords in a cord drive, for instance, may be such that they are either hard to reach when the cord is way up (and the blind is in the fully lowered position), or the cord may drag on the floor when the blind is in the fully raised position. Also, for heavy blinds, a large force may be required on the cord in order to lift the blind.

SUMMARY OF THE INVENTION

The present invention provides a cord drive which has the advantages of prior art cord drives, plus it eliminates many of the problems of prior art cord drives. One preferred embodiment of the present invention provides a cord drive which does not require the drive cord to travel as far as the lift cord. It also permits the use of a drive cord loop, which always has the same exposed length regardless of the position or length of the blind.

Note that, for the purposes of this description, we will hereafter refer to two drive cords, each having one end mounted on the cord drive. However, it should be understood that the language referring to two drive cords includes the situation in which the two drive cords are connected together to form a loop so that they are, in effect, a single cord having one end mounted on each spool of the cord drive.

In the present invention, the drive cord in the cord drive is a totally different cord from the lift cord which attaches to the bottom rail.

An objective of the present invention is to have a simple wind up spool system with a minimum of moving parts, which will consistently and reliably wind and unwind the drive cords without jamming or over-wrapping, and with the ends of the drive cords exiting the cord drive always at the same location instead of moving along the length of the wind up spool.

To accomplish these goals, a preferred embodiment of the cord drive includes two spools which rotate as a single piece. The drive cords are counter-wrapped onto the spools such that, as both spools rotate in the same direction, one cord is unwinding from its respective spool, while the second cord is winding onto its spool. Finally, the spools have a slight taper at the inlet end, where the drive cords are first wrapped onto the spools, and the cord drive includes a cover which not only accurately positions the cords onto the tapered section of the spools: it also has a clearance of less than twice the diameter of the drive cord between the outer tapered surface of the spool and the inner surface of the cover. Thus, as the cord is placed onto the tapered surface of the spool, the drive cord wraps are displaced axially along the length of the spool and down the tapered surface of the spool, and the clearance will not allow an over-wrap condition to occur. The cover may also provide support for the spools; it may guide the drive cords so they exit the cord drive at the same location all the time; and it may also provide a mounting mechanism to mount the cord drive to the head rail.

When the cord drive is used for a blind, the drive spools may be connected to the rest of the blind mechanism by means of a lift rod or drive shaft. In fact, the lift rod may be the mechanism linking the two spools together so that they rotate as a single unit, as is the case in some preferred embodiments. Then, as a drive cord end is pulled in the cord drive mechanism, it unwinds from a first spool and makes this first spool rotate. The rotation of this first spool causes the lift rod to rotate which causes a second spool to rotate, thus causing the other drive cord to counter-wrap onto this second spool. The rotation of the lift rod may also cause a lift station to rotate, winding or unwinding the lift cord to raise or lower the blind, depending on the direction of rotation.

While the present invention is shown being used in a typical horizontal Venetian blind, it should be obvious to those skilled in the art that this cord drive may be used in any number of different types of mechanical drives.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a partially broken away perspective view of a blind incorporating a cord drive made in accordance with the present invention;

FIG. **2** is a perspective view of the cord drive of FIG. **1**;

FIG. **3** is an exploded perspective view of the cord drive of FIG. **2**;

FIG. **3**A is an enlarged side view of one of the spools of FIG. **3**;

FIG. **4** is a perspective view of a second embodiment of a cord drive made in accordance with the present invention;

FIG. **5** is an exploded perspective view of the cord drive of FIG. **4**;

FIG. **6** is a perspective view of a third embodiment of a cord drive made in accordance with the present invention;

FIG. **7** is an exploded perspective view of the cord drive of FIG. **6**;

FIG. **8** is a perspective view of a fourth embodiment of a cord drive made in accordance with the present invention but with the cords removed for clarity;

FIG. **9** is a rear view of the cord drive of FIG. **8**;

FIG. **10** is a sectional view along line **10**—**10** of FIG. **9**, again with the cords removed from the spools for clarity;

FIG. **11** is a front view of the cord drive of FIG. **8**;

FIG. **12** is a sectional view along line **12**—**12** of FIG. **10**, now showing the cords;

FIG. **13** is a sectional view along line **13**—**13** of FIG. **9**, again showing the cords;

FIG. **14** is a sectional view along line **14**—**14** of FIG. **10**, now showing the cords;

FIG. **15** is a schematic, broken away, perspective view of a fifth embodiment of a cord drive made in accordance with the present invention, where the cover has been removed for clarity;

FIG. **16** is a front view of the cord drive of FIG. **15**;

FIG. **17** is a schematic top view of a sixth embodiment of a cord drive made in accordance with the present invention, again with the cover removed;

FIG. **18** is a schematic, broken away, perspective view of a seventh embodiment of a cord drive made in accordance with the present invention, where the cover has been removed for clarity;

FIG. **19** is a schematic end view of an eighth embodiment of a cord drive made in accordance with the present invention, where the cover has been removed for clarity;

FIG. **20** is a schematic, broken away, perspective view of a ninth embodiment of a cord drive made in accordance with the present invention, where the cover has been removed for clarity; and

FIG. **21** is a schematic front view of a tenth embodiment of a cord drive made in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. **1**, the blind **10** includes a head rail **12**, and a plurality of slats **14** suspended from the head rail **12** by means of tilt cables **18** and the associated cross cords **19**, which together comprise the ladder tapes, as is well known in the art. Front and back lift cords **16** extend through the head rail and along the front and back of the stack of the slats **14**, and are fastened at the bottom of the bottom slat (or bottom rail) **14**A, which is heavier than the other slats **14**. Inside the head rail **12** are a counter wrap cord drive **50**, two lift and tilt modules **60**, a transmission **30**, which is close coupled to a spring motor **40**, and a lift rod or drive shaft **20**, which interconnects the counter wrap cord drive **50** with the lift modules **60** and the transmission **30**.

FIG. **6** shows a perspective view of the cord drive **50** of FIG. **1**. This cord drive **50** is identical to the cord drive **54** of FIGS. **8**–**14**, which is described below in detail, except that this cord drive **50** has a longer cover **108**, both radially and axially, than the cover **108** of the cord drive **54**.

Referring now to FIGS. **8**–**14**, the cord drive **54** includes left and right spools **102**, left and right drive cords **106** (See FIGS. **1**, **10**, **11**, **12**, and **14**), a lift rod or drive shaft **20**, and a cover **108**. The two spools **102** are identical but are arranged in mirror image positions relative to each other, with the inlet portions of the two spools **102** adjacent each other. As will be seen in other embodiments described later, they may be made as a single piece. The spools **102** are hollow, substantially cylindrical members with an inside surface **110** which has a non-circular profile (See FIGS. **12**–**14**) that closely matches the external profile of the lift rod or drive shaft **20** so that the spools **102** rotate with the drive shaft **20**.

The spools **102** have a tapered outside surface **112**, which tapers from its maximum diameter at the inlet end of the spool (near the center of the cord drive unit **54**) to its minimum diameter at the outer end of the spool. The maximum diameter inlet end terminates in a flange **114**, and the minimum diameter end has a short slit **115** (See FIGS. **3**A, **8**, **15**, and **16**) used to secure one end of the respective drive cord **106** to its spool **102**. FIGS. **15** and **16** are schematic views showing spools similar to the spools **102** of FIGS. **8**–**14**, but clearly showing the cords wrapped onto the spools. In order to fasten the drive cord **106** to the spool **102**, an enlargement, such as a knot (not shown), is tied to an end of the drive cord **106**. This knot is slid behind the slit **115** at the end of the spool **102**, and thus the drive cord **106** is quickly and easily secured to the end of the spool **102**. Beyond the flange **114** of the spool **102** is a short, hollow, stub shaft **116** having a smaller outside diameter than the flange **114**. (See FIGS. **10** and **13**). The stub shaft **116** supports one end of the spool **102**, as will be explained later.

Looking more closely at the tapered surface **112** of the spool **102** (See FIG. **3**A), this tapered surface **112** has four distinct segments **112**A, **112**B, **112**C, and **112**D. Segment **112**A is closest to the flange **114** and receives a shoulder **122**, as will be explained later. It is the shortest segment and may be either cylindrical or it may have just enough taper as is required for mold release in the fabrication process. The second segment **112**B is also short (though longer than segment **112**A) and has the steepest taper of the four segments **112**A, **112**B, **112**C, **112**D. The second segment **112**B is the inlet portion of the spool **102**. The taper on this segment **112**B should be selected so that it is neither too steep nor too shallow. If the taper is too steep, the cord **106** will slide down to the minimum diameter in one wrap, which is undesirable. The last wrap of cord **106** laid on the tapered surface **112**B carries the largest part of the load (in this instance, the weight of the stack of blinds being raised or lowered). Thus, it is desirable that this last wrap of cord **106** rest on the tapered surface **112**B so that, as the next wrap of cord **106** is also laid on the tapered surface **112**B, the pre-existing wrap of cord **106** will no longer be carrying the largest part of the load (since the latest wrap of cord **106** will now be the last wrap of cord **106** and it will now have absorbed the largest part of the load). Thus, the preexisting wrap of cord **106** is no longer carrying the brunt of the load and it will be easily displaced toward the smaller diameter. If, on the other hand, the taper of segment **112**B is too shallow, this pre-existing wrap of cord **106** will tend not to readily slide down to the smaller diameter.

The third segment **112**C is the longest segment and is used primarily for storage of the cord **106**. This segment **112**C may be referred to as the storage portion of the spool. The amount of taper present in this segment preferably is only that required for easy molding of the component, and this segment could be cylindrical (no taper at all) because, at this point, there is virtually no compression between the cord wraps and the cylinder surface, which allows the cord draft to be easily displaced toward the outer end (the end opposite the flanged **114**). The final segment **112**D begins with the base of the slot **115** and the amount of taper present in this segment **112**D is unimportant and in fact it is typically cylindrical, because no cord **106** wraps occur in this area. So, the inlet portion **112**B of the spool **102** has a substantial taper, with its diameter decreasing in the direction of the storage portion **112**C. The storage portion **112**C has substantially less taper than the inlet portion **112**B, with the storage portion **112**C having little or no taper.

The cover **108** serves several functions. First, it serves as a support for the spool **102** (together with the lift rod **20**). It also serves as a mounting mechanism to mount the cord drive **54** onto the head rail **12**. It also serves as a mechanism to guide the drive cords **106** onto the inlet portions of the spools **102**, as well as off the spools **102** and through the head rail **12**.

The cover **108** is a one-piece construction having left and right portions, which are mirror images of each other. Each portion of the cover **108** is designed to fit over the flange **114** end of one of the spools **102** in such a manner so as to lock the flange **114** in position against axial displacement while allowing free rotation of the spool **102**. The cover **108** includes two inner projecting surfaces **118** (See FIGS. **10** and **13**), each of which serves as an axial stop preventing the flange **114** of its respective spool **102** from moving axially inwardly, toward the center of the drive unit **54**. At the same time, a semi-circular profile **120** on these inner projecting surfaces **118** provides a bearing surface to support the stub shaft **116** of its respective spool **102**. Two outer shoulders **122** (See FIG. **10**) project inwardly on the inside surface of the cover **108**. Each of these shoulders **122** acts as a second axial stop on the other side of the flange **114** of its respective spool **102**, preventing the spool **102** from moving axially outwardly, away from the center of the drive unit **54**. Thus, the flange **114** of each spool **102** is effectively trapped between one of the outer shoulders **122** and one of the projecting surfaces **118** of the cover **108**, thus fixing the axial location of the spool **102** relative to the cover **108**. The cover **108** also has two short hoods **124**. Each hood **124** provides a clearance of less than twice the diameter of the drive cord **106** between the tapered outer surface **112** of the spool **102** and the inner surface of the hood **124**, which prevents the cord **106** from overwrapping.

As shown in FIG. **10**, on the right side, the hood **124** also defines a substantially axially-oriented, convex curve on its inner surface, which helps guide the cord over a large radius as it is unwrapping from distant portions of the spool, in order to prevent the cord from having to make a sharp turn, and thereby minimizes friction.

The cover **108** has forward and rear upwardly projecting ears **126** and a forwardly projecting foot **128**. The foot **128** fits inside an opening in the bottom of the head rail **12** to lock the cord drive **54** against horizontal movement relative to the head rail **12**. The two ears **126** snap into the profile of the head rail **12** to lock the cord drive **54** against vertical movement relative to the head rail **12**. The foot **128** has two holes **130**, **131** through which the drive cords **106** pass in order to extend through the cord drive **54** and through the head rail **12**. Thus, the drive cords **106** always exit the head rail **12** at the same place, through the two holes **130**, **131** in the foot **128** of the cover **108** of the cord drive **54**.

The cover **108** also has two additional holes **132**, **134** (See FIG. **11**). One hole **132** is at a height which is above the axial centerline of the cord drive **54** and is used to guide one drive cord **106** as it comes into the cord drive **54**, to place the drive cord **106** on the tapered surface **112** of the first spool **102** such that, when the first spool **102** is turned counterclockwise (as seen from the vantage point of FIGS. **12** through **14**), the first drive cord **106** winds onto the first spool **102**. The second hole **134** is at a height which is below the axial centerline of the cord drive **54** and is used to guide the second drive cord **106** as it comes into the cord drive **54** to place it on the tapered surface **112** of the second spool **102** such that, when the spool **102** is turned counterclockwise (as seen from the vantage point of FIGS. **12** through **14**), the second drive cord **106** unwinds from its spool **102**. Thus, the two drive cords **106** are counter-wrapped onto their respective spools **102**, meaning that, as the spools **102** rotate together, one drive cord **106** winds onto its respective spool as the other unwinds. In this embodiment, both spools **102** rotate together and in the same direction because they are both non-rotatably mounted on the same lift rod or drive shaft **20**. Thus, the two spools **102** rotate as a single unit. As the first drive cord **106** is pulled, it unwinds from the first spool **102**, causing the drive shaft **20** to rotate in a first direction, while the second drive cord **106** winds onto the second spool **102**. The clearance of less than two times the cord diameter between the tapered surface **112** of the spool **102** and the hood **124** on the cover **108** prevents any over-wrap condition from occurring, and, as each successive wrap of drive cord **106** wraps onto its respective spool **102**, it displaces the previous wrap of drive cord, shoving it sideways, axially along the tapered surface **112** of the spool **102**. Similarly, as the second drive cord **106** is pulled, it unwinds from the second spool **102**, causing the drive shaft **20** to rotate in the opposite direction, while the first drive cord **106** winds onto the first spool **102**.

To assemble the cord drive **54**, an end of a drive cord **106** is secured to its respective spool, via a knot or other enlargement, which is slid behind the slit **115**. The drive cord **106** is threaded through a hole **132** or **134** in its respective cover **108** (going from the inside of the cover **108** to the outside of the cover **108**), and it is further threaded through a hole **130** or **131** in the foot **128** of the cover **108**. The spool **102** is then installed by pushing it up from under the cover **108** such that the stub shaft **116** pushes against the upwardly projecting surface **118**, which has just enough flexibility in it to bend axially to allow the stub shaft **116** to slide past the surface **118**, and thus allows the spool **102** to snap into place such that its flange **114** is trapped between the shoulder **122** and the projecting surface **118** of the cover **108**, and the stub shaft **116** on the spool **102** is supported by the semi-circular profile **120** on the projecting surface **118**. The spool **102** is then manually rotated in the appropriate direction until most of the drive cord **106** is wrapped onto its spool **102**. This same procedure is followed for a second spool **102** and a second drive cord **106** except that, once the second spool **102** is snapped into place, its corresponding drive cord **106** is not wrapped onto it but is simply secured at the slit **115** and is threaded through its respective holes in the cover **108**.

The assembled cord drive **54** is then mounted onto the head rail **12** by inserting the foot **128** in an opening (not shown) in the head rail **12** for that purpose. The cord drive **54** is then pushed down until the ears **126** snap into the profile of the head rail **12**. Finally the lift rod or drive shaft **20** is inserted through the hollow inside surface **110** of both spools **102**, and is extended through to connect to the lift modules **60** which are already connected to the lift cords **16** connected to the bottom rail **14A** of the stack of slats in a manner which is well known in the art.

Now, as the end of the first, wrapped drive cord **106** is pulled, it unwraps from its spool **102**, rotating the spool **102** as well as the lift rod **20**. The second spool **102** also rotates with the lift rod **20**, and in the same direction, wrapping the second drive cord **106** onto the second spool **102** as the first drive cord **106** is unwrapping from the first spool **102**. Since the lift rod **20** is also connected to the lift module **60**, the lift module **60** will also rotate and thus raise or lower the stack of slats.

At this point, the first drive cord **106** is unwrapped from the first spool **102**, and the second drive cord **106** is wrapped on the second spool **102**. As this second drive cord **106** in turn is pulled to unwrap form the second spool **102**, it causes the lift rod or drive shaft **20** to rotate in the opposite direction, and it causes the first drive cord **106** to wrap onto the first spool **102**. Thus, one drive cord **106** is always wrapping onto a spool **102** as the other drive cord **106** is being pulled and unwrapped. The cover **108** directs the incoming cord **106** onto the tapered inlet portion **112**B of the outer surface **112** of the spool **102**, where it is displaced down, axially along the taper toward the storage portion **112**C of the spool **102** as a successive wrap is laid onto the tapered surface **112**B of the spool **102**. The hood **124**, with its clearance of less than two drive cord diameters, ensures that no over-wrap condition occurs, so that the cord drive mechanism **54** will not jam or otherwise malfunction, since there is not enough clearance for two wraps of the drive cord **106** on top of each other.

Alternate Embodiments

What is described above with respect to FIGS. **8–14**, is actually the fourth embodiment shown in the attached drawings. The first embodiment of a cord drive **50** is shown in FIGS. **1**, **6**, and **7**. The only significant differences between the first embodiment of a cord drive **50**, as shown in FIGS. **1**, **6**, and **7**, and the fourth embodiment **54** described earlier is that the cover **108**A of the first embodiment has longer hoods **124**A extending axially as well as a longer foot **128**A extending radially. The longer hoods **124**A have hooks **136**A used to secure the cord drive **50** to the head rail **12** instead of the ears **126** found in the fourth embodiment **54**. The longer foot **128**A is used when mounting the cord drive **50** onto a wide head rail **12** in order to ensure that the drive cords **106** exit through the head rail **12** at its front edge. These differences between the first and fourth embodiments of the present invention have no effect on the operation of the cord drive. In this and other embodiments to be described later, similar parts are given the same number followed by a "letter" to designate a difference. For instance, the cover in the fourth embodiment, shown in FIGS. **8–14**, is item **108** while in the first embodiment, shown in FIGS. **1**, **6** and **7**, this cover is item **108**A.

FIGS. **2** and **3** depict a second embodiment of a cord drive **50**B. The cover **108**B is a combination of the covers from the first and fourth embodiments described earlier. The longer hoods **124**B are present but without any hooks. Instead, ears **126**B are used, similar to those in the fourth embodiment **54**. The foot **128**B is also essentially identical to the foot **128** of the fourth embodiment **54**. Once again, this cord drive **50**B operates in the same manner as the cord drive of FIGS. **8–14**.

FIGS. **4** and **5** depict a third embodiment of a cord drive **50**C. The cover **108**C is essentially identical to that of the second embodiment **50**B, except that the hoods **124**C have a larger radius in order to accommodate the larger diameter spools **102**C. These larger diameter spools **102**C are the significant difference of this embodiment **50**C from those described earlier. The larger the effective diameter of the outer surface **112**C of the spool **102**C, the less mechanical force is required to raise or lower the stack of blinds, but the more travel is required of the drive cords **106**. For instance, if the diameter of the spool **102**C is the same as the diameter of the lift spool on the lift module **60**, the force required to raise or lower the blinds is relatively small, but the drive cords **106** must travel the same distance as the blinds. That is, for every foot of rise (or fall) of the bottom head rail **14A**, each of the drive cords **106** must also travel one foot. On the other hand, if the diameter of the spool **102**C is one half the diameter of the lift spool on the lift module **60**, the force required to raise or lower the blinds will be twice as large as in the previous case, but the drive cords **106** will now travel only half the distance traveled by the blinds. That is, for every foot of rise (or fall) of the bottom head rail **14A**, each of the drive cords **106** must travel only half a foot. The fact that twice the motive force is required is not a serious drawback, especially in a counterbalanced transport system as described in U.S. patent application Ser. No. 09/528951, filed Mar. 20, 2000. In this instance, the system is in balance and only a small catalytic force is required to offset the balance and overcome the system inertia so as to raise or lower the blinds.

FIGS. **15** through **23** depict additional embodiments of cord drives made in accordance with the present invention. These are depicted in a schematic form with some of the elements, such as the cover and in some instances also the drive cords, omitted for ease of showing the operating mechanism.

FIG. **17** depicts a cord drive **50**F which is representative of the embodiments described thus far, namely two independent tapered spools **102**F connected by a lift rod **20**. The two separate spools **102**F allow a space in between them to install a support structure at the point where the downward forces are applied to the spools **102**F by the action of pulling on the drive cords **106**. As with the first through fourth embodiments, in this case the two spools **102**F rotate together by being non-rotatably mounted on the same drive shaft or lift rod **20**. Thus FIG. **17** schematically depicts any of the embodiments already described.

As shown in FIGS. **15** and **16**, the two spools **102**E may be placed abutting each other, and in fact may actually be a single piece, which would make the spool piece stronger and may thus eliminate the need for a support structure. In this case, the two spools **102**E may be a unitary piece either by being formed as a single member or by being made of a plurality of members that are adhered, riveted, bolted, snapped together, or otherwise secured together to function as a unitary piece. The combination of a strong unitary spool **102**E and the lift rod **20** may provide enough support that a separate supporting structure becomes unnecessary. The operating principle remains the same as that of previously described embodiments, with one drive cord wrapping onto its spool while the other cord unwraps.

FIGS. **18** and **19** show seventh and eighth embodiments, both of which use gears to cause the spools to rotate together. One advantage of these embodiments is that the drive cords **106** may now be made to exit at an end of the head rail **12**, instead of exiting to one side (front or rear) of the head rail **12**.

The seventh embodiment **50**G, shown in FIG. **18**, has two parallel tapered spools **102**G which end in gears **138**. The lift rod or drive shaft **20**, which is parallel to the spools **102**G, also has a gear **140** at one end, and this gear **140** is meshed with both spool gears **138**, causing the spools **102**G to rotate together in the same direction. Thus, when one of the drive cords **106** is pulled so as to unwind from its spool **102**G, its associated gear **138** will rotate, thereby driving the lift rod gear **140** and the lift rod **20**, which also rotates and drives the lift spool of the lift module **60** so as to raise or lower the blinds. The lift rod gear **140** is also meshed with the spool gear **138** of the other spool **102**G, and thus the rotation of the lift rod gear **140** also drives the second spool gear **138**, causing the second spool gear **138** to rotate in the same direction as the first spool gear **138**. Since the drive cords **106** are wrapped onto their corresponding spools **102**G in opposite directions, as both spools **102**G rotate in the same direction, one drive cord will be unwinding while the drive cord will be winding onto its spool. The lift rod gear **140** may be of a different size than that of the spool gears **138**. If the lift rod gear **140** is larger in diameter than the spool gears **138**, then the mechanical advantage will be greater, but the drive cords **106** will have to travel a longer distance than the vertical distance traveled by the blind. On the other hand, a smaller lift rod gear **140** (relative to the spool gears **138**) will have less mechanical advantage, but a shorter distance of travel by the drive cords **106** will result in a longer vertical distance traveled by the blind. Thus, by varying the relative effective diameters of the spool gears **138** relative to the lift rod gear **140**, the same effect may be achieved as by varying the effective wrap diameter of the spools relative to the lift spool on the lift module **60**.

The eighth embodiment **50**H, shown in FIG. **19**, is similar to the seventh embodiment previously described. The spools **102**H once again are identical and, as in the previous embodiment **50**G, they end in gears **138**H. However, in this embodiment, the lift rod gear is eliminated, the lift rod **20** is connected directly to the center of one of the geared spools **102**H, and the two spool gears **138**H are meshed with each other, causing the spools **102**H to rotate together in opposite directions. One significant difference of this embodiment **50**H from that of all other embodiments described thus far is that the drive cords **106** are NOT wrapped in opposite directions. Instead, they are both wrapped in the same direction onto their respective spools, because the spools rotate in opposite directions. The gear action reverses the direction of rotation of the spools **102**H such that, when one cord **106** is being pulled to unwind from, and rotate, its corresponding spool **102**H, the second drive cord **106** is wrapping onto its corresponding spool **102**H. Except for this difference, the principle of operation of this embodiment **50**H is identical to that of the previously described embodiment **50**G. One advantage of this embodiment **50**H over that of the previous embodiment **50**G is that it requires less width to fit in the head rail **12**.

FIG. **20** depicts a ninth embodiment of a cord drive **50J** in accordance with the present invention. This embodiment **50J** is very similar to the fifth embodiment **50E** shown in FIGS. **15** and **16**. It should be noted that any of the spools **102** previously described may be tapered along their entire length, or they may be tapered only for a short length, in the area where the cover places the drive cord **106** onto the spool. The remainder of the length of the spools may be non-tapered.

FIG. **20** depicts two spools **102J** (which may be formed as a unitary piece as has already been described), each spool **102J** having a short tapered inlet section **142J** adjacent to a non-tapered storage section. The storage section of each spool defines one or more key-ways **146J** which run longitudinally, parallel to the axis of the spool **102J**. Two anchoring disks **148J**, having an inside diameter just slightly larger than the outside, non-tapered diameter of the storage sections of the spools **102J**, have internal projections **150J** which fit into the key-ways **146J**. The disks **148J** freely slide axially along the storage sections of their respective spools **102J** but must rotate with the spools **102J** and the drive shafts **20**, because the projections **150J** of the anchoring disks **148J** engage the key-ways **146J** of the spools **102**.

One end of each drive cord **106** is secured to its respective spool by being secured to a sliding anchoring disk **148J**, instead of being secured directly to the end of the spool as has been described for the previous embodiments. The rest of the installation and operation is identical to that described for the fourth embodiment **54**. However, one may notice in FIG. **20** that the successive wraps of drive cord **106** on the spools **102J** are tight one against the other, as opposed to the successive wraps of cord **106** on the previous embodiments, as shown in FIGS. **15** and **16**, where there is a gap between adjacent wraps, and this gap becomes more pronounced as there are fewer wraps remaining on the spool **102**E. In this latest embodiment of a cord drive **50J**, as the drive cord **106** is wound onto the spool **102J**, the cord wraps push against the disk **148J** which then slides axially away from the tapered section of the spool **102J**. As the drive cord is unwound from the spool **102J**, the disk is pulled axially by the cord **106**, toward the tapered inlet section of the spool **102J**. This has two positive effects on the design and performance of the cord drive **50J**:

First, the length of the spool **102J** may be cut in half from that of an equivalent cord drive of the non-sliding disk design, because there are no gaps in successive wraps of the drive cord **106**. The wraps of drive cord are always tight, one wrap against the next.

Second, the unwinding force remains constant throughout the entire run-out of the cord. In a non-sliding disk design (such as that depicted in FIG. **15**), the initial angle of the wound-up drive cord **106** is 90° (perpendicular to the axis of rotation of the spool). With successive revolutions of the spool, as the drive cord unwinds, the angle approaches closer to the axial direction of the spool. This causes the force required to continue the unwinding process to increase with each successive revolution as an increasingly larger part of the force is wasted pulling horizontally against an unyielding point (where the drive cord is attached directly to the spool). In the sliding disk embodiment **50J**, the disk is continually moved axially so that the drive cord **106** is always perpendicular to the axis of rotation of the spool **102J**. Thus, the unwinding force remains constant, and at a minimum, throughout the entire range of the drive cord **106**.

FIG. **21** shows a tenth embodiment of a cord drive **50K** made in accordance with the present invention. This embodiment is very similar in concept to the ninth embodiment **50J** described earlier, except that, in this embodiment, the storage portions of the spools are adjacent to each other, the inlet portions **152K** are at the outer ends of the spools **102K**, and a single sliding disk **148K** anchors the ends of both cords **106**. (Note that, in order to mount the disk **148** K onto the spool **102K**, one of the pieces, either the disk **148K** or the spool **102K**, should be made in at least two parts).

The drive cords **106** are counter-wrapped onto the spools **102K**, and the ends of the drive cords **106** are secured to the common disk **148K**. As one drive cord **106** is pulled to unwind from its spool **102K**, the other drive cord **106** will automatically wrap onto its spool **102K** and at the same time push the disk **148K** axially so that there are not any gaps on successive wraps of the drive cord **106**, whether winding or unwinding. The exit point of the drive cords **106** is still fixed relative to the head rail **12**, as is the case for all previous embodiments described thus far; they are just a little further apart from each other than they have been in previous embodiments.

While several embodiments of the present invention have been described above, it is not possible or required to show every conceivable embodiment of the invention in order for all the possible embodiments to be covered by the claims of this patent application. Therefore, it will be obvious to those skilled in the art that modifications may be made to the embodiments described above without departing from the scope of the present invention.

What is claimed is:

1. A cord drive, comprising:

first and second spools, each of said spools being tapered from a larger diameter inlet portion to a smaller diameter storage portion;

means for causing said first and second spools to rotate together; and

first and second cords mounted on said first and second spools, respectively, wherein pulling said first cord causes said first cord to unwrap from said first spool and said second cord to wrap onto said second spool, and pulling said second cord causes said second cord to unwrap from said second spool and said first cord to wrap onto said first spool.

2. A cord drive as recited in claim **1**, wherein said inlet portion has a substantial taper and said storage portion has little or no taper.

3. A cord drive as recited in claim **1**, wherein said cords define a diameter, and further comprising a cover mounted over at least one of said spools and one of said cords, said cover defining a gap between the cover and its respective spool of less than two of said cord diameters to prevent overwrapping of said one cord.

4. A cord drive as recited in claim **1**, wherein said cords have ends fixed to their respective spools.

5. A cord drive as recited in claim **1**, wherein said means for causing said first and second spools to rotate together includes said first and second spools being a unitary piece.

6. A cord drive as recited in claim **1**, and further comprising a first anchoring member mounted on said first spool, said anchoring member being keyed to said first spool so that said anchoring member is axially movable but not rotatable relative to said first spool, and wherein said first cord has an end secured to said anchoring member.

7. A cord drive as recited in claim **6**, wherein said first and second spools are coaxial and said second cord has an end that is also secured to said anchoring member.

8. A cord drive as recited in claim **6**, and further comprising a second anchoring member keyed to said second spool so that said second anchoring member is axially movable but not rotatable relative to said second spool, and wherein said second cord has an end secured to said second anchoring member.

9. A cord drive as recited in claim **1**, wherein said first and second spools are coaxial.

10. A cord drive as recited in claim **9**, wherein said inlet portions of said first and second spools lie adjacent to each other.

11. A cord drive as recited in claim **9**, wherein said storage portions of said first and second spools lie adjacent to each other.

12. A cord drive as recited in claim **1**, and further comprising a drive shaft, wherein said means for causing said first and second spools to rotate together includes said first and second spools being non-rotatably mounted on said drive shaft for rotation with said drive shaft.

13. A cord drive as recited in claim **1**, wherein said means for causing said first and second spools to rotate together includes a plurality of meshed gears.

14. A cord drive as recited in claim **13**, wherein said first and second spools rotate together in the same direction.

15. A cord drive as recited in claim **13**, wherein said first and second spools rotate together in opposite directions.

16. A cord drive as recited in claim **1**, and further comprising a drive shaft driven by said first and second spools.

17. A cord drive as recited in claim **16**, and further comprising a lifting spool driven by said drive shaft, and a lift cord having first and second ends, the first end of said lift cord being mounted on said lifting spool.

18. A cord drive as recited in claim **17**, wherein said cord drive is mounted on a covering for architectural openings including a bottom rail, and wherein the second end of said lift cord is secured to said bottom rail.

19. A cord drive as recited in claim **1**, wherein each of said spools has an axis of rotation, and further comprising housings mounted over said first and second spools and fixed in the axial direction relative to said spools, said housings having inner surfaces which define guide paths for guiding the cords onto the inlet portions of said first and second spools.

20. A cord drive as recited in claim **19**, wherein said spools have the same axis of rotation, said housings are secured together to ensure that the guide paths are fixed relative to each other, and said guide paths guide the cords to wrap in opposite directions onto said first and second spools.

21. A cord drive as recited in claim **20**, wherein said housings are made as a single piece.

22. A cord drive as recited in claim **21**, wherein said cords define a diameter, and wherein said housings define gaps between the housings and their spools of less than two of said cord diameters to prevent overwrap.

23. A cord drive as recited in claim **10**, wherein there is a bearing surface between, and of a smaller diameter than, the inlet portions of the spools for supporting the spools.

24. A cord drive as recited in claim **19**, wherein at least one of said housings further defines a substantially axially-oriented, convex curve on its inner surface, which guides the cord over a large radius as it is unwrapping from distant portions of the spool in order to minimize friction.

25. A cord drive, comprising:

first and second coaxial spools, each of said spools including a large diameter, substantially tapered inlet portion and a smaller diameter storage portion adjacent to its respective inlet portion, wherein each inlet portion tapers down toward its respective smaller diameter storage portion, said inlet portions lying adjacent to each other and being tapered in opposite directions; and

first and second cords secured to said first and second coaxial spools, respectively;

said first and second spools being mounted so as to rotate together, and said cords being wrapped onto their respective spools, such that, pulling said first cord causes said first cord to unwrap from said first spool and said second cord to wrap onto said second spool, and pulling said second cord causes said second cord to unwrap from said second spool and said first cord to wrap onto said first spool.

26. A cord drive as recited in claim **25**, wherein each of said first and second spools defines a slit distant from its inlet portion, each of said cords has a cord end, and each of said slits receives its respective cord end, thereby securing the respective cord end to the respective spool.

27. A cord drive as recited in claim **25**, and further comprising first and second axially slidable anchoring members mounted on said first and second spools, respectively, said first and second axially slidable anchoring members being keyed to their respective spools, wherein said first and second cords are secured to said first and second anchoring members, respectively.

28. A covering for architectural openings, including:

a head rail;

a covering suspended from said head rail and including a bottom rail;

a lift cord suspended from said head rail and secured to said bottom rail;

a lift spool rotatably mounted in said head rail, said lift cord mounted on said lift spool for raising and lowering said covering;

a drive shaft which drives said lift spool;

first and second drive spools mounted so as to rotate together and to drive said drive shaft, each of said first and second drive spools defining an inlet portion and a storage portion adjacent to the inlet portion, wherein the inlet portion has a large diameter at one end and tapers down toward the smaller diameter storage portion;

first and second drive cords mounted on said first and second drive spools, wherein pulling said first drive cord causes said first drive cord to unwrap from said first spool and said second drive cord to wrap onto said second spool, causing said first and second spools to rotate said drive shaft and said lift spool in a first direction to wrap said lift cord onto said lift spool, raising said bottom rail and said covering, and, wherein, pulling said second cord causes said second cord to unwrap from said second spool and said first cord to wrap onto said first spool, causing said first and second spools to rotate said drive shaft and said lift spool in an opposite direction to unwrap said lift cord from said lift spool, lowering said bottom rail and said covering.

29. A covering for architectural openings as recited in claim **28**, wherein said first and second spools are a unitary piece.

30. A covering for architectural openings as recited in claim **28**, wherein said first and second spools are non-rotatably mounted on said drive shaft.

31. A covering for architectural openings as recited in claim **28**, and further comprising a plurality of meshed gears mounted so as to cause said first and second spools to rotate together.

32. A covering for architectural openings as recited in claim **28**, wherein said first and second spools are mounted so as to rotate together in the same direction.

33. A covering for architectural openings as recited in claim **28**, wherein said first and second spools are mounted so as to rotate together in opposite directions.

34. A covering for architectural openings as recited in claim **28**, wherein said first and second spools are coaxial and said inlet portions of said spools lie adjacent to each other.

35. A covering for architectural openings as recited in claim **28**, wherein said first and second spools are coaxial and said storage portions of said spools lie adjacent to each other.

36. A covering for architectural openings as recited in claim **28**, wherein said first and second drive cords are mounted in slits in said first and second spools, respectively.

37. A covering for architectural openings as recited in claim **28**, and further comprising a first axially slidable, anchoring member non-rotatably mounted on said first spool, wherein said first cord is mounted on said first anchoring member.

38. A covering for architectural openings as recited in claim **37**, wherein the first and second spools are coaxial, and the storage portions of the spools lie adjacent to each other, and both said first and second cords are mounted on said first anchoring member.

39. A covering for architectural openings as recited in claim **37**, and further comprising a second axially slidable anchoring member non-rotatably mounted on said second spool, wherein said second cord is mounted on said second anchoring member.

40. A cord drive, comprising:

first and second spools mounted so as to rotate together;

first and second cords mounted on said first and second spools such that pulling said first cord causes said first cord to unwrap from said first spool and said second cord to wrap onto said second spool, and pulling said second cord causes said second cord to unwrap from said second spool and said first cord to wrap onto said first spool; and

a first axially slidable anchoring member non-rotatably mounted on said first spool, wherein the first cord is mounted on said first anchoring member.

41. A cord drive as recited in claim **40**, and further comprising a second axially slidable anchoring member non-rotatably mounted on said second spool, wherein the second cord is mounted on said second anchoring member.

42. A cord drive as recited in claim **40**, wherein said second cord is also mounted on said first anchoring member.

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